INTEGRATED WASTE MANAGEMENT PRIMER

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

INTEGRATED

WASTE

MANAGEMENT

PRIMER

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TABLE OF CONTENTS

Water Use/Waste Water Disposition

Noise/Odor

Other Impacts

Permitting Requirements/Siting

LANDFILLS

Transfer Stations

SUMMARY

With many of California's communities facing a possible garbage disposal crisis in the near term, the State enacted AB 939, the California Integrated Waste Management Act of 1989. AB 939 calls on local governments to develop and carry out integrated waste management plans. In developing these plans, AB 939 mandates that local governments follow a new statewide hierarchy of waste management options, with emphasis first on source reduction; next on recycling and composting programs; and finally on environmentally safe transformation (e.g. waste-to-energy facilities) and landfilling. AB 939 also requires cities and counties to divert 25 percent of their solid waste from disposal through source reduction, recycling, and composting by January 1, 1995. A 50 percent diversion rate is mandated by January 1, 2000.

This primer is designed to provide a readable guide on integrated solid waste management options, issues, and implementation strategies. It is meant to serve as an educational tool for Bay Area community leaders and neighborhood groups of the concerned with or responsible for solid waste disposal.

Some of the major conclusions of the primer are briefly summarized below.

Source Reduction

Source reduction refers to any action that reduces the quantity of garbage generated. Examples of source reduction include decreasing unnecessary packaging, using products with greater durability and repairability, and banning the sale and use of products that are not biodegradable or that are environmentally damaging. One of the major constraints of these programs is that they require long-term changes in production and consumption patterns. Even with this constraint, however, source reduction can greatly decrease the quantity and toxicity of waste in the future.

Recycling

Recycling is the process of separating, collecting (before or after separation), processing, and using waste as the raw material for new products. Materials typically recycled include: newsprint, mixed paper, aluminum, steel and bimetal cans, container glass, cardboard, and office paper. Currently, there are thousands of

residential, commercial, and industrial recycling programs operating across the country.

Locally, recycling benefits include: revenue earned from the sale of materials; disposal fees saved by not landfilling recyclables; and extension of local landfill life by as much as 50 percent. On a larger scale, recycling conserves valuable resources, and saves energy. It is also compatible with transformation (e.g. waste-to-energy) facilities, particularly when facilities are sized to take into account maximum recycling levels. One of the major constraints of recycling is the lack of stable markets for diverted materials. To this end, federal and state policies are needed to stimulate future demand for recovered materials. Assuming markets continue to develop, recycling will likely play a major role in diverting large quantities of garbage from disposal in the future.

Composting

Composting is the biological decomposition of organic matter into humus — a product suitable for use as a soil amendment or landfill cover. Major benefits of composting include reducing the volume of garbage going to landfill (by 15 to 50 percent) and producing a variety of usable soil products. Major constraints of successfully operating a composting program include: the lack of available, inexpensive land in major urban areas; siting constraints due to environmental health and economic concerns; lack of product markets; and potential health concerns associated with levels of trace metals, toxic chemicals, or microorganisms found in the final product. Even with these potential constraints, there were close to 1,000 composting operations in the country, primarily composting yard wastes, in 1989. This figure is expected to grow rapidly in the future.

Waste-to-Energy

Waste-to-energy (WTE) technology involves incinerating garbage either "en-masse" or in a shredded, pelletized, or other processed form. The generated heat from the combustion process is used to make steam. This steam is then used for process or space heating applications or to generate electricity. At the local level, benefits of waste-to-energy include weight and volume reduction of the waste stream, which may result in saving tipping fees, and in generating energy for local use. Globally, the benefits include decreased reliance on scarce fossil fuels, and conservation of the nation's landfill disposal capacity. Currently, there are 122 WTE facilities operating in 36 states across the country. Three WTE facilities are operating in California.

- The two most common environmental and public health concerns associated with WTE facilities are air emissions and ash disposal, as detailed below.

  — Air Emissions: Anytime anything is burned, air emissions are created. No air pollution control technology or combination of technologies can eliminate all air emissions. However, by using the "best available control technologies" (BACT) and by properly designing and operating the combustion system, WTE facilities can comply with all current federal, state, and local air emissions limits for criteria pollutants (e.g., sulfur dioxide, nitrogen oxides) and operate within acceptable health standards. Although there are no specific emissions limits for noncriteria pollutants (e.g., dioxins, furans), current air pollution control technologies, along with proper combustion controls, can reduce emissions to levels necessary to meet current standards.

  — Ash Disposal: Ash is a solid material resulting from the combustion process. There are two types of ash: (1) bottom ash — unburned and unburnable material remaining on the combustion grates or in the furnace after refuse is combusted; and (2) fly ash — a much finer material with higher concentrations of heavy metals recovered from flue gases going through the air pollution control equipment. The major concern about fly ash is that toxic substances in it — particularly dioxins, furans, and heavy metals (e.g., mercury, lead, and cadmium) — will come into contact with the environment or the public at concentrations that create health and other problems. A number of steps can be taken to reduce these risks. To reduce the potential for leaching of ash in a landfill and potential contamination of surface and groundwater, ash can be disposed of in a separate landfill cell (monofill) with a special landfill liner and leachate treatment system. To reduce air emissions while handling, transporting, and disposing of ash, the ash should be covered while it is transported to an appropriate landfill All ash landfilling techniques require the approval of the Regional Water Quality Control Board.

Landfills

Landfills in the new waste hierarchy are to be used as the final resting places for those wastes that cannot be reduced, recycled, reused, or incinerated. In addition, as wastes decompose, methane gas is produced which can be harvested and used on-site for power generation or sold as fuel. Unfortunately, improperly sited, designed, and operated landfills may produce potential environmental impacts. For example, groundwater can seep into a landfill, mix with liquid waste, and produce "leachate." If adequate precautions are not taken in locating, designing, and constructing a landfill, contaminants in the leachate can pollute the water supply. Recent research has also shown that the total amount of carcinogenic substances emitted into the air from a landfill, even under controlled conditions, is significant. In fact, they may exceed those that are emitted from a controlled WTE facility, which is processing an equal amount of municipal waste.

Integrated Waste Management

An integrated approach to waste management conserves resources. Assuming that a city generates 100,000 tons of garbage annually, that its garbage generation grows about 1.5 percent annually, and that it has 1.5 million tons of remaining landfill capacity, the following conclusions will be true:

- If the city pursues a "landfill only" approach, its landfill capacity will last 12.5 years.

- If the city pursues an "integrated" approach through source reduction, recycling, and composting and attains a 50 percent diversion goal by the year 2000, its landfill capacity will last 20 years.

- If the city pursues an "integrated" approach through source reduction, recycling, and composting programs and attains a maximum 40 percent diversion goal by the year 1998, <u>and</u> sends the remainder of its refuse (in the year 1999) to an environmentally sound waste-to-energy facility, its landfill capacity will last 27 years.

An integrated approach to waste management is more environmentally sound than the traditional "landfill" approach because it places primary emphasis on reducing, recycling, and reusing garbage prior to incineration or disposal. For example, source reduction programs can reduce toxic packaging, such as styrofoam and plastics, thus improving air and water quality. By recovering paper, glass, and cans through recycling programs, we

can conserve valuable resources, such as mineral deposits and forest lands, and save energy. Composting programs produce a valuable soil conditioner out of the organic portion (e.g. food waste, leaves) of our garbage.

Even if source reduction, recycling, and composting efforts result in diverting as much as 50 percent of garbage from disposal, a community would be better off sending the remaining garbage to an environmentally and economically sound WTE or other transformation facility than a landfill. Not only would a WTE facility produce energy and reuse portions of garbage not diverted by source reduction, recycling, and composting programs, but it would further extend valuable landfill capacity.

In developing an integrated waste management plan, a local government should carry out five basic steps. The first step is establishing goals — defining what the future solid waste system should accomplish. The second step is evaluating how effectively the existing system accomplishes these goals. The third step is to identify a range of technologies (e.g., recycling, composting) or programs in source reduction, recycling, and composting. The fourth step is evaluating each of the new options and selecting the set of programs that best serve the community's needs. The final step of the planning process involves developing a detailed implementation strategy with implementation schedules and budgetary milestones.

I. Introduction

BACKGROUND

"Californians can no longer rely on landfills for inexpensive, long-term garbage disposal."

Mayor Roberta Hughan, City of Gilroy

Not only is the quantity of waste produced in California expected to increase from the current 38 million tons per year to 45 million tons per year by the year 2000, but remaining landfill capacity is shrinking rapidly in many parts of the State. In fact, a number of California counties will run out of landfill capacity within the next decade unless new landfills are sited. And to make matters worse, siting a new landfill is virtually impossible. Due to environmental concerns and strong regional opposition, only two landfills have been cited in major communities in California since 1980. The end result of increasing waste quantities, decreasing landfill capacity, and siting difficulties is that landfill disposal costs are increasing and are expected to continue to increase in the future.

"We need to aggressively pursue a variety of nondisposal options to ease the landfill crunch."

Supervisor Anna Eshoo, San Mateo County — 3rd District

"Tie an environmentally sound resource recovery facility to a strong recycling program and we just might have the next century's solution to garbage disposal."

Supervisor Rod Diridon, Santa Clara County — 4th District

With many of California's urban areas facing a possible garbage disposal crisis in the near term, the State enacted AB 939, the California Integrated Waste Management Act of 1989. AB 939 calls on local governments to develop and carry out integrated waste management plans. In developing these plans, AB 939 mandates that local governments pursue a statewide hierarchy of waste management options, with emphasis first on source reduction; next on recycling and composting programs; and finally, on environmentally safe transformation (e.g., waste-to-energy facilities) and land disposal. AB 939 also requires cities and counties to divert 25 percent of solid waste from disposal

through source reduction, recycling, and composting by January 1, 1995. By January 1, 2000, a 50 percent diversion rate is mandated.

Properly planned and implemented source reduction, recycling, composting and waste-to-energy options will have a significant impact on easing the disposal situation. However, many city and county officials in California and throughout the Bay Area are unfamiliar with the technical, economic, and environmental implications of implementing these options. In addition, each local government must determine which set of options best meets its needs.

For example, local officials will be asked to make decisions on questions such as:

- What will waste collection and disposal cost?
- Who will collect and dispose of garbage?
- What types of source reduction recycling programs should be implemented?
- Should a waste-to-energy facility be constructed?
- Where should transfer stations, landfills, and waste-to-energy facilities be located?
- What new waste management programs are needed?
- What are the environmental and economic consequences of choosing one option over another?

HISTORY AND PURPOSE OF THE PRIMER

> **"We want to present factual information about solid waste management options in lay terms and in a form as complete as possible."**
>
> Councilperson Paul Cooper, City of Pleasant Hill

Throughout the 1980's, numerous waste-to-energy projects were proposed but were eventually turned down by local jurisdictions due to public concerns about the environment. By 1988, there were so many concerns and questions about the pros and cons of siting and operating a WTE facility, the Bay Area Air Quality District formed the Ad Hoc Committee on Resource Recovery (now renamed the Ad Hoc Committee on Integrated Waste Management). The Ad Hoc Committee decided to oversee the development of a waste-to-energy primer focusing on key issues and developments in that field. Soon thereafter, the Ad Hoc Committee decided to expand the scope of the primer to include key information about other major solid waste management options (i.e. source reduction, recycling, composting).

The purpose of this primer is to provide a readable guide on the "first principles" of integrated solid waste management options, issues, and implementation strategies. This primer is specially designed to serve as

an educational tool for community leaders and neighborhood groups of the Bay Area concerned with or responsible for solid waste disposal.

The reader should note that while the primer does discuss all of the major waste management options, a large portion of the document focuses on waste-to-energy facilities. Placing greater emphasis on waste-to-energy in this primer is due in part to the complexity of health and environmental issues related to these facilities, as well as to the original intent of the document.

ORGANIZATION OF THE PRIMER

This primer is organized into three major sections. **Section II — Overview of Solid Waste Management** provides information on solid waste disposal in the Bay Area and California; a summary of waste management options; and an overview of California's Integrated Waste Management laws. **Section III — Technical, Economic, and Environmental Issues** describes the major integrated waste management options and cites the latest research on the pros and cons of each option in terms of its operating history, air pollution emissions and other environmental impacts, economics, financing, permitting and regulatory requirements, and markets, where appropriate. **Section IV — Selecting, Integrating, and Implementing Options** details the major components of an integrated waste management plan, discusses how two or more waste management options fit together, and delineates methods for selecting and implementing these options.

In support of this work, **Appendix A** provides a glossary of solid waste terms and acronyms for easy reference; **Appendix B** provides a list of footnote references used to develop information in the primer.

II. Overview of Solid Waste Management

The basis for understanding solid waste management is knowing what solid waste is, and what can be done with it. This section presents a definition of solid waste, examines the generation of solid waste in the Bay Area and the state, defines "integrated waste management," and provides options available for managing the solid waste stream.

MUNICIPAL SOLID WASTE TRENDS

1. What is municipal solid waste (MSW)?

The term municipal solid waste (MSW), more commonly known as garbage, refers to materials that we choose to discard. It includes such things as food scraps, yard waste, metals, plastics, glass, dirt and rocks, wood, and paper. MSW does not include: hazardous waste; "designated" and "special" wastes (e.g., biomedical wastes); and mining and agricultural wastes. MSW is customarily divided into several main categories:

Residential — Wastes produced by single-family and multifamily dwellings.

Commercial — Wastes generated by stores, offices, and other commercial establishments.

Industrial — Nonhazardous wastes produced by factories, machine shops, and other industries.

Institutional — Nonhazardous wastes produced by hospitals, jails, universities, and other institutions. These wastes are often categorized with commercial or industrial wastes.

In the typical Californian community, about half of all MSW is produced by households, and the remaining wastes are equally divided between commercial and industrial sources. Some cities and towns, however, produce little or no commercial and industrial waste, whereas others generate large quantities of nonresidential waste.

2. How much of the MSW generated in California and in the Bay Area requires disposal?

Few people in the United States generate as much waste as the typical Californian, who produces more than 2,500 pounds of MSW annually. This is significantly more than the 1,500 pounds of MSW generated by the average American.

In 1989, Californians generated nearly 38 million tons of MSW that required disposal. Of that amount, approximately 6.7 million tons of MSW were generated within the nine Bay Area counties (Table 2-1).

3. How is the solid waste stream changing?

The solid waste stream is changing in two ways: in quantity and composition.

Projections of solid waste generation indicate that the amount of waste requiring landfilling statewide will rise from current levels of 38 million tons per year (TPY) to more than 43 million TPY by 1995. In the Bay Area, solid waste requiring landfilling is expected to grow from 6.8 million TPY to 9.4 million TPY by 1995. These increases are a result of population growth and increased per-person waste generation.

Waste volumes (i.e., space taken up by waste) are increasing even faster than weight increases, because lighter materials are replacing denser materials in our waste stream. Specifically, there has been a steady increase in plastics and paper, and corresponding decreases in glass and metals (Table 3-1). These increases are in part a result of changes in the types and amounts of packaging used, such as the shift from glass bottles to plastic bottles and paper cartons for beverages. Other waste stream changes shown in Table 3-1 include a reduction in food waste and a decline in yard waste generation. Reduction in food waste may be due to increased consumption of convenience food and use of kitchen garbage disposals. This means wastes such as bones and peelings are reduced. The reduction in yard wastes may possibly reflect smaller yards, or less time spent tending them.

Table 2-1

Waste Quantities Generated Requiring Disposal in Bay Area Counties and the State of California, 1989 (Tons Per Year Projected)

Area	Waste Disposal Requirements (tons/year -1989)
California	38,000,000
Bay Area Counties	
Alameda	1,807,000
Contra Costa	930,000
Marin	228,000
Napa	190,000
San Francisco	725,000
San Mateo	675,000
Santa Clara	1,489,000
Solano	288,000
Sonoma	401,000
Bay Area Total	6,733,000

From "Integrated Solid Waste Management: Putting a Lid on Garbage Overload," Assembly Office of Research, 1988.

Table 3-1

Past and Projected Composition of U. S. Municipal Solid Wastes

Materials	1978[a] (% of Total Waste)	2000 projected[b] (% of Total Waste)
Paper Products	29.7	41.0
Glass	10.7	7.6
Metals	9.6	9.0
Plastics	4.2	9.8
Rubber, Leather & Textiles	4.9	4.6
Wood	3.4	3.8
Food	16.8	6.8
Yard Waste	19.2	15.3
Other	1.5	2.1
Totals	100	100
Total U.S. MSW Generation	138.9 million tons per year	159 million tons per year

(a) From "Solid Waste Dates: A Compilation of statistics on Solid Waste Management within the United States," published by *Resource Recovery Report*, August 1981.

(b) From "Integrated Solid Waste Management: Putting a Lid on Garbage Overload," Assembly Office of Research, 1988.

INTEGRATED WASTE MANAGEMENT

4. What is integrated waste management?

The term "integrated waste management" refers to the complementary use of a variety of waste management options (e.g., source reduction, recycling, composting, landfilling, and incineration). Its goal is to effectively handle all solid waste in a coordinated and environmentally sound manner.

To accomplish this goal, various wastes are matched with those management options that best suit them, in order to reduce toxics, reduce volume, and conserve energy and resources. Those wastes that cannot be reduced, reused, or recycled are then incinerated or disposed of in a landfill.

5. What integrated waste management options can local governments pursue to deal with the solid waste problem?

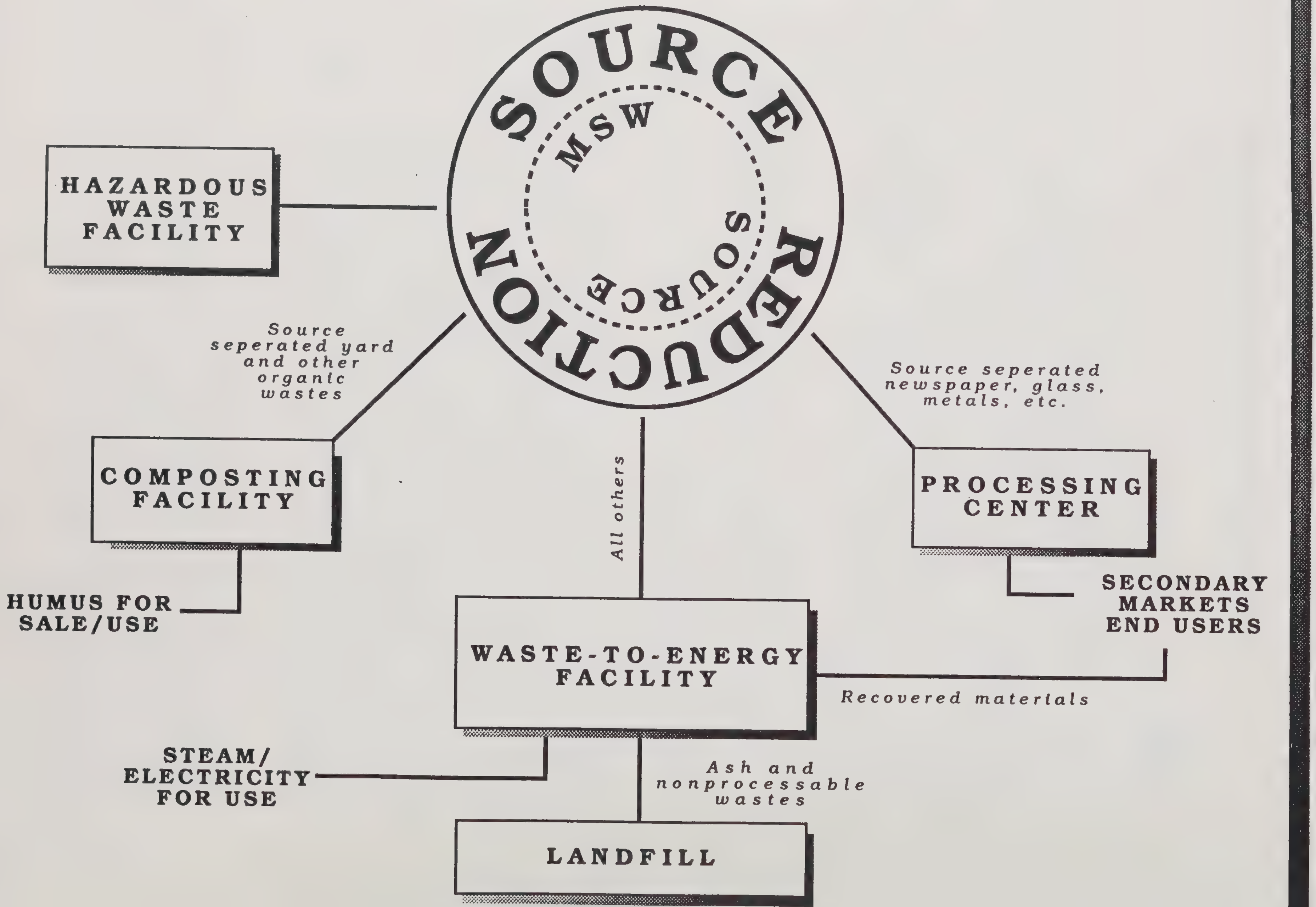
There are five major options that local governments can pursue to manage solid wastes. None of these options are mutually exclusive.

Source Reduction: Source reduction is any action that reduces the quantity of waste generated. Examples of source reduction programs include: enacting legislation that limits the amount of product packaging or that bans toxic packaging; increasing product durability and reusability; and educating consumers about the pros and cons of various types of product packaging. At the local level, source reduction benefits include avoiding waste collection, processing, and/or disposal fees; conserving local landfill capacity; and improving air and water quality.

Recycling: Recycling is the process of separating, collecting (before or after separation), processing, and utilizing a waste material as the raw material for products that may or may not be similar to the original product. Materials typically recycled include: newsprint, mixed paper, aluminum, steel and bimetal cans, container glass, cardboard, and (increasingly) plastics.

Communities have a variety of recycling options available. Residences, commercial establishments, and institutions may separate recyclable materials from their regular garbage and either take them to a recycling center or dealer or have them collected. Recycling can also take place at a central facility, where recyclable materials are recovered manually and/or mechanically from the mixed waste stream. Once processed (e.g., crushed, flattened, or baled), recycled materials are remanufactured into new products. Locally, recycling benefits include: revenues earned from

Figure 4.1
An Integrated Waste Management Example



the sale of materials; avoided costs (disposal fees saved by not landfilling recyclables); processed raw materials for local industry and extension of local landfill capacity. On the global level, recycling conserves valuable resources, including mineral deposits and forest lands, and saves energy.

Composting: Composting is the biological decomposition of organic matter (e.g., yard wastes, food waste, sewage sludge) into humus suitable for use as a soil amendment or as an intermediate, absorptive landfill cover. Composting activities can range from simple composting of yard waste such as leaves, to the more complex composting of the mixed waste stream. The end-product varies depending on the nature of the starting material, the composting process selected, and the extent of decomposition. Most commercial composting activities involve heaping the organic materials into windrows (long piles) where they are allowed to decay. If the windrows are kept moist and turned or otherwise aerated at regular intervals, no disagreeable odors will develop. The time required for decomposition depends greatly on ambient climate, moisture content, and materials being worked with. The benefits of composting include the generation of a valuable soil supplement, volume reductions of the waste stream by 40 to 50 percent, and extension of existing landfill capacity.

Waste-to-Energy: Waste-to-energy is a "transformation" technology that involves incinerating the waste stream (or some portion thereof) either "en masse" or in a shredded, pelletized, or other processed form. The heat generated from the combustion process is used to make steam. This steam is then used for process or space heating applications; or to generate electricity. "Mass burning" and "modular" waste-to-energy systems burn MSW "as is," generally without sizing, shredding, or separating it before burning. "Refuse-derived fuel" systems separate the combustible portion of the waste stream from the noncombustible portion (dirt, grit), using a series of shredders, screens, and air classifiers. Once separated, the more homogeneous combustible fuel is then burned in a boiler on-site, or is marketed as a fuel to outside users. At the local level, benefits of waste-to-energy include weight and volume reduction of the waste stream, which may result in saved tipping fees, and in generating energy for local use. Globally, the benefits may include decreased reliance on scarce fossil fuels, and conservation of the nation's landfill disposal capacity.

Landfilling: Landfilling is by far the most common means of waste disposal, disposing of 90 percent of California's and the country's MSW. Landfills are the final resting place for wastes that are not reduced or recovered and for the residual matter produced after MSW has been processed and energy and materials have been recovered. Landfilling involves placing wastes in an excavated area (or "cell"). They are then covered with earth at the end of each day. A landfill may have one or many alternate layers (or "lifts") of wastes and earth within it. Modern landfills typically use plastic or clay liners that serve as a barrier between

wastes and the ground. Collection systems are often used to collect and burn methane gas that forms underground as wastes decay. Once a landfill reaches its capacity, a thick final layer of earth is placed over it and the area is replanted with grasses and trees.

6. What integrated waste management laws have been adopted by the State of California?

In September 1989, two important integrated waste management bills were signed into law: AB 939 and SB 1322.

AB 939 (Sher), the California Integrated Waste Management Act of 1989, establishes a full-time California Integrated Waste Management Board (CIWMB). The Act also requires the development of County Integrated Waste Management Plans with both city and county elements; establishes a new hierarchy of waste management options with an emphasis on source reduction and recycling (see Question 7); requires the attainment of specific local waste diversion goals (see Question 8); and revises facility permitting and local enforcement programs. The AB 939 planning process also replaces the existing County Solid Waste Management Planning process on January 1, 1990, although the state has not worked out full details for the transition from one to the other.

SB 1322 (Bergeson) establishes a comprehensive set of state programs to encourage source reduction and recycling and to develop recycled materials markets. All of the programs under SB 1322 are consistent with the Integrated Waste Management hierarchy established under AB 939 (see Question 7).

For an overview of specific elements in AB 939 and SB 1322, refer to Sidebar 6.1 and Sidebar 6.2, respectively.

SIDEBAR 6.1

AB 939 (Sher)
KEY PROVISIONS

AB 939 establishes a new set of principles to guide the State of California in its future integrated waste management plans. Key elements of the bill are outlined below.

California Integrated Waste Management Board (CIWMB)

- AB 939 creates a new full-time CIWMB to replace the existing State Solid Waste Management Board by July 1, 1990.

- The bill also strengthens conflict-of-interest provisions for future board members and for board employees.

Goals

- AB 939 created the following waste management hierarchy, designed to make optimum use of each option:

— Source reduction
— Recycling and composting
— Transformation (incineration) and land disposal

- Cities must achieve a 25 percent disposal diversion by 1995 and a 50 percent diversion by 2000.

City and County Planning Requirements

- Local task forces: Counties are required to establish local task forces. These task forces will identify county or regional issues; help develop city source reduction and recycling elements; help prepare the countywide siting element; and help develop multi-jurisdictional arrangements to market recyclable materials.

- City and County (Unincorporated Area) Source Reduction and Recycling Elements (SRREs or Plans) must be developed. The SRREs will have the following nine components:

  — Waste characterization
  — Source reduction
  — Recycling

SIDEBAR 6.1 (continued)

- — Composting
- — Education and public information
- — Funding
- — Special waste
- — Facility capacity
- — Household hazardous waste

- The elements must demonstrate how 25 percent of waste will be reduced, recycled, and composted by 1995, and how 50 percent will be diverted by 2000.

- Countywide siting elements: Counties must demonstrate sufficient land disposal and incineration capacity to provide for 15 years of waste management, in addition to reduction and recycling. Counties may tentatively reserve areas of land for such use.

- Countywide Integrated Waste Management Plans:

  — Counties are required to submit the plan to the State Integrated Waste Management Board. The plan will consist of three components: the county source reduction and recycling element (unincorporated areas); the countywide siting element; and the various city source reduction and recycling elements.

  — The plan must be sent to the state on January 1, 1992, 1993, or 1994, depending on whether the county has less than five years of landfill capacity; five to eight years of capacity; or over eight years of capacity, respectively.

- Additional state actions affecting local planning

  — The bill creates source reduction and recycling guidelines for preparing city elements and county plans.

  — Additional guidelines regarding other components of the city and county source reduction and recycling elements will be developed over time.

- Other provisions:

  — The roles that state and local agencies play in permitting solid waste facilities will be modified.

  — AB 939 also modifies the local enforcement agency process for overseeing whether a facility complies with permit requirements.

SIDEBAR 6.2

SB 1322 (Bergeson)
KEY PROVISIONS

SB 1322 establishes a comprehensive set of state programs that are consistent with the hierarchy established under AB 939. Specifically, SB 1322 focuses on state and local government policy designed to create markets for recyclables. Key elements of the bill are outlined below.

Source Reduction

- SB 1322 creates a Source Reduction Advisory Committee to recommend actions for reducing the volume of waste materials. These actions include:

  — Packaging and product design improvements
  — Developing product durability standards
  — Developing methods to increase recycled feedstock use
  — Reducing toxicity of packaging and products
  — Evaluating new technology developments

Market Development

- The California Recycling Markets Development Commission would be developed to review the progress of market development for recyclable materials; to promote such development as specified; and to report annually to the Governor and the Legislature. Specifically, it:

  — Creates recycling market development zones with regulatory and fiscal incentives to attract private recycling investors. Zones will be proposed by local agencies following regulations and guidelines to be adopted by the board.

  — Creates state program to recycle office paper, compost, and plastics.

  — Designs a program for state agency purchase of recycled office paper, recycled plastics, retreaded tires, recycled batteries, and use of compost materials.

SIDEBAR 6.2 (continued)

Technical Assistance

- SB 1322 assists local governments and the private sector in:
  - Providing local enforcement agency training.
  - Conducting waste reduction evaluations of the waste stream of individual offices/subunits of government and business.
  - Establishing office paper recycling programs.

Public Information and Education

- A statewide program would be developed to encourage participation in all phases of integrated waste management (IWM), with source reduction and recycling to be the primary focus.
- SB 1322 directs the CIWMB and the State Department of Education to develop materials to teach source reduction, recycling, and integrated waste management in schools.

Research and Development

- The bill develops a state research and development program to assist local governments and private industries in waste reduction (including research facilities at universities and colleges). It also provides recycling research grants to qualified small businesses and establishes a clearinghouse for recycling research information.

7. 

Are there State guidelines for choosing between various integrated waste management options?

Yes. AB 939 establishes a "hierarchy of integrated waste management options" to guide the California Integrated Waste Management Board and local governments in developing and implementing integrated waste management plans. The hierarchy calls for the promotion of various waste management options in the following priority:

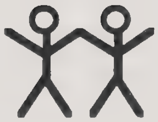
(1) Source reduction;
(2) Recycling and composting; and
(3) Environmentally safe transformation (e.g., waste-to-energy facilities, pyrolyzer) and environmentally safe land disposal, at the discretion of the local governments.

AB 939 also instructs the CIWMB and local governments to maximize the use of all feasible source reduction, recycling, and composting options in order to reduce the amount of MSW that must be disposed of by transformation and land disposal. For wastes that cannot feasibly be reduced at their source, recycled or composted, local governments may use environmentally safe transformation, land disposal, or both.

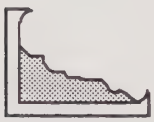
8. **Do California's integrated waste management laws establish minimum waste diversion goals for local governments?**

Yes. AB 939 requires cities and counties to divert 25 percent of their solid waste from disposal through reduction, recycling, and composting programs by January 1, 1995. By January 1, 2000, a 50 percent diversion rate is mandated.

As part of their integrated waste planning process, cities and counties are required to show specific programs and implementation schedules for attaining the 25 percent and 50 percent diversion goals. The California Integrated Waste Management Board may allow alternate goals if the 50 percent goal is proven not to be feasible.

9.  **Is it practical to expect that a single option will solve all of our future solid waste needs?**

No, nor is it particularly desirable. Our solid waste stream is truly a mixed bag of materials with many different physical and chemical properties. Each option available to a community is useful in managing particular parts of the waste stream (also known as "subflows"). Several examples follow. Certain materials in the waste stream are toxic and are best managed through a waste reduction program. Source separation and recycling can effectively and economically recover newspaper, cardboard, office paper, glass, and metals, but it is often difficult to find markets for low-grade wastepaper and mixed plastics. However, these materials could be managed in an environmentally sound waste-to-energy facility. Landfilling yard wastes consumes valuable disposal capacity and loses the nutritive value of such wastes. Furthermore, yard wastes may also create technical difficulties for waste-to-energy facilities. Yet if yard wastes are composted, the generated humus can be used in land applications. In summary, if we continue to pursue a single option as we have in the past (e.g., landfilling), we lose access to valuable resources in our waste stream, use up rapidly diminishing landfill capacity, and increase the risk of future air, water, and land pollution.

10.  **Can we eliminate the need for landfills in the future?**

No. The landfill will always have a role in future solid waste management systems, because no single waste management system can be relied on to handle every material or subflow of the waste stream. A portion of the waste stream will always require landfilling. Recycling activities cannot recover every type of waste we discard, composting works with only certain organic components of the waste stream, and incineration generates ash and cannot process certain "bypass" waste (e.g., large tree stumps), which require disposal in a landfill. Therefore, landfilling currently remains the only viable means to dispose of those wastes that cannot otherwise be eliminated, reduced, reused, recycled, composted, or incinerated. Trying to eliminate our need for landfills is probably an unattainable goal. Given the realities of our waste generation and the difficulties of siting new facilities (due to stringent state and federal standards and growing public opposition) a more reasonable goal is to conserve what capacity we now have. This can be done by first maximizing reduction, recycling, and composting programs; then constructing environmentally sound waste-to-energy facilities; and finally siting new landfills as necessary.

III. Technical, Environmental and Economic Evaluations

Every integrated waste management option provides opportunities for managing various materials in the waste stream. However, each option has certain constraints. This section describes each major option in detail and cites the latest research on its pros and cons. Specifically, the following factors for each option are reviewed (where appropriate): technical performance; operating history; air pollution and other environmental impacts; economics; financing; permitting and regulatory requirements; and the availability of markets.

SOURCE REDUCTION

11. What is source reduction? What are some of the opportunities and constraints of implementing these programs?

Source reduction involves reducing the quantity of waste generated. Source reduction can be achieved by the following means:

- Decreasing unnecessary or excessive packaging;
- Developing and using products with greater durability and repairability (e.g., more durable appliances and tires);
- Substituting reusable products for disposable, single-use products (e.g., reusable plates and cutlery, refillable beverage containers, cloth diapers and towels);
- Using fewer resources (e.g., two-sided copying);
- Increasing the recycled materials content of products; and
- Developing rate structures that encourage generators to produce less waste.

Effective source reduction programs can significantly reduce the quantity of waste generated. Studies in Michigan and Minnesota indicate the solid waste load could be cut by 10 percent through reductions in packaging. According to these studies, new designs for steel cans, glass bottles, shipping cartons, and newspaper could reduce the use of raw materials by 20 to 25 percent.[1] Another source reduction approach — increasing the recycled material content of products — could significantly reduce raw materials usage and increase market demand for recyclable materials. Source reduction programs can also be used to ban the sale and use of products that are not biodegradable and are environmentally damaging (e.g., plastics).

Source reduction programs have several major constraints. First, unlike other waste management options that could have an almost immediate effect on the waste stream (e.g., curbside collection, waste-to-energy), effective source reduction programs will require major, long-term changes in production and consumption patterns. Second, one of the major targets of source reduction programs — packaging — performs critical functions, such as decreasing food spoilage and preventing tampering. New packaging laws must take this into consideration. Finally, measuring quantity reduction as a result of these programs is difficult, given that there is no standard method for determining how much is generated.[2] Nonetheless, developing baseline source reduction survey data from residences and commercial establishments and updating the data on an annual basis can provide information on the existence and magnitude of source reduction efforts.

Implementation of source reduction and reuse programs may not have an immediate impact on the quantity of refuse diverted from a landfill. However, these programs can reduce waste quantities and waste toxicity over time, which will greatly improve our quality of life in the future.

12. What kind of programs can federal, state, or local governments institute to encourage source reduction?

Federal, state, and local government agencies can encourage source reduction through legislation, in-house efforts, public education, and technical assistance programs.

A comprehensive legislative program could include legislation that: establishes standards for reducing packaging materials used in consumer products; creates tax credits and/or exemptions to stimulate industry to design more durable products, establishes minimum performance standards (i.e., warranties); and bans materials, containers, or packaging that threatens the environment (e.g., styrofoam, cadmium, lead-based inks). The program could also fund research and development efforts to find suitable replacements for lead, cadmium, and other potentially hazardous materials used in manufactured goods.

In-house governmental source reduction efforts may include: purchase of durable materials (e.g., 50,000 mile tires); reuse of materials (copying draft reports on backs of scrap paper); using double-sided copying; and giving a preference for recycled or recyclable materials in the procurement process. Governments can also implement an in-house "forms management" program, aimed at reducing the number of forms (memos, etc.) generated; as well as expand their office automation to include electronic mail, which can further reduce the amount of paper generated.

Perhaps the most important element of a successful source reduction program is a well-designed public education and technical assistance program. Such a program should be designed to educate public officials, members of business and industry, and citizens about source reduction issues. This would include a list of potentially cost-saving source reduction options and tips for implementing these options.

RECYCLING

Technologies

13. What are the major types of recycling programs?

A variety of recycling approaches are available for recovering materials that are source-separated, i.e., separated from wastes that are generated at home or in the work place. Depending on such factors as population, housing type and density, demographics, topography, commercial activity, current recycling levels, and future recycling goals, a community may want to implement one or more of the recycling programs described below.

Drop-off recycling centers: The most common recycling service in the country, drop-off centers are often run by charitable groups for fund raising. The public is asked to separate materials, transport them to the center, and place them in appropriate containers. Centers may accept newspaper only, such as Boy Scout-sponsored paper drives, or they may accept a wide variety of paper, metal, glass, and other recyclables at a permanent facility.

Buy-back centers: With a staff and regular hours of operation, buy-back centers purchase recyclables directly from the public. Buy-back centers typically recycle larger quantities than drop-off centers. This is because people will generally travel farther and bring more materials to a buy-back center, given the cash incentive.

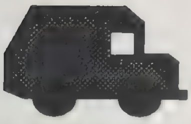
Curbside recycling programs: These programs provide residents with the greatest level of recycling convenience. Regular collection routes, often scheduled on a weekly basis, provide a frequent and reliable pick-up service for household recyclables. Typical recyclables collected by programs are newspaper, with cardboard, plastics, motor oil, and mixed wastepaper sometimes included. Curbside recycling programs are usually city-sponsored and a well-designed program can divert from 10 to 25 percent or more of the residential waste stream.[3]

Commercial recycling programs: Private recycling firms usually set these programs up in large cities and metropolitan areas. Old corrugated containers (cardboard) are the most common materials collected from the commercial sector. They comprise a large percentage of the waste generated by wholesalers, retailers, and manufacturers. Glass bottles are another material often targeted for commercial recycling. Bars and restaurants are supplied with containers, so glass can be stored separately. Glass-recycling firms provide regular pick-up service and delivery to the processing facility.

Office paper recovery: Office paper recovery programs are being implemented by many governmental offices and private companies (especially in the education, utility, banking, and insurance sectors). These programs require employees to keep various types of paper (for example, letterhead, computer printouts, and memos) separate from their regular waste. The paper is collected and eventually transported to a market (either a recycling firm or a waste hauler). Since major responsibility for the program lies with the employee, employee education and program monitoring are key to its success.

Materials recovery facilities: Materials recovery facilities (MRF's) are becoming more prevalent as a major component of integrated waste management systems. These facilities are used for large-scale sorting and processing of recyclables. Incoming materials to a facility may consist of source-separated recyclables, mixed recyclables, or mixed-waste containing recyclable materials. A combination of sorting stations, conveyors, magnetic separators, glass crushers, high-density balers, can crushers, and other processing equipment are typically used to prepare recyclables for shipment to markets. The use of manual labor for some of the sorting process is required, regardless of the mechanical features of the system. The specific design of the processing operation will depend to a large degree upon the type of materials targeted, the form in which they are received, and the requirements of the materials market.

Materials recovery operations that target mixed waste streams are often coordinated with transfer station facilities and can serve as the first sorting stage for waste-to-energy facilities, or in conjunction with composting operations. Examples of MRF's in the Bay Area include the Marin Resource Recovery Facility in San Rafael, The Recyclery in Belmont, and the Recycle America facility in San Jose.

14. 

Are local communities in California and across the country implementing recycling programs?

Yes. In California and other states, especially where landfill capacity is rapidly diminishing, more communities are implementing curbside and other recycling programs. In 1989, over 600 multimaterial curbside programs were in operation in the United States, and hundreds more will be coming on-line in the next few years, so household source separation of recyclables is becoming increasingly common. About one-third of the more than 100 curbside collection programs in California are operating in communities in the Bay Area, providing weekly service to half a million households.

Drop-off centers, especially for newspaper and glass, have also been placed in numerous locations in the Bay Area. They are serviced by a collection route system using large-capacity vehicles that can collect from many locations in one day.

Commercial recycling of corrugated cartons and glass containers is also on the rise. The City of San Jose recently launched a pilot commercial recycling program designed to stimulate recycling in the commercial/industrial sector. The service provider for curbside programs in the nine cities in San Mateo County also provides commercial recycling services under its contract. The Marin Resource Recovery Center in San Rafael is recycling close to 50 percent of the selected loads of commercial/industrial wastes coming to that facility. Over 2,600 bars and restaurants in California established industry-sponsored collection and recycling programs during 1987 to 1988.[4] Office paper recycling is becoming more widespread as local governments adopt their own in-house programs and the private sector uses this recycling option as a sound business practice.

The introduction in 1987 of California's Beverage Container Recycling and Litter Reduction Act (the "Bottle Bill") established approximately 2,400 new certified recycling centers throughout the state.[5] These centers were placed at supermarket locations so that the public could conveniently recycle their aluminum, and plastic beverage containers.

Program Design

15. What goes into a successful recycling program?

Many different types of recycling programs are in operation throughout the country. The programs that are most successful in achieving high

participation and material recovery rates take steps to ensure that the program is convenient and practical. Based on some successful Bay Area programs, we have outlined measures to employ that will help ensure high participation rates:

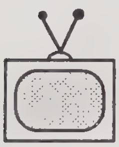
Good program planning: Establish realistic goals for the various types and amounts of materials to be collected and the amount of revenue to be received. Make an accurate assessment of equipment and personnel needs.

Recycled materials markets: Determine whether a market exists for each recycled material. If it does, analyze what the future demand will be, as well as its price and material specifications (for example, acceptable levels of contamination and moisture). Then a sound marketing strategy should be outlined, which may include long-term market contracts, cooperative marketing efforts with other recycling operators in the region, and export opportunities.

Public convenience: Make sure that participating in the program is convenient. For example, provide household storage containers to residents for curbside collection or establish weekend business hours for buy-back centers.

Public awareness: Build community pride and program participation through a well-directed public awareness campaign.

Program reliability: Establish and maintain a high level of service. This way the public knows it can rely on the recycling program regardless of internal problems, such as poor market conditions, equipment down-time, or personnel changes.



16. What public education and publicity methods have encouraged citizens to participate in recycling programs?

Educating the public about the benefits and ease of recycling is key to creating a recycling ethic and encouraging citizen participation. Successful programs have employed a variety of methods to get the recycling message across to their community. Some of the more effective publicity programs have utilized a central theme and program identity, while others may focus on door-to-door contact as a means of getting residents interested in and supportive of the recycling program.

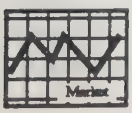
The message: Developing a central theme incorporating a logo, slogan, color-scheme, program name, and special community characteristics helps provide an easily recognized recycling service. The public can

identify the program with the positive values of recycling when the message is direct and the appeal is consistent.

The messenger: Many programs credit door-to-door contact for increasing public participation. At the beginning of a new recycling service, door-to-door visits by volunteers or even canvassers paid to announce the service and encourage participation have proven very effective. In El Cerrito, canvassers surveyed residents about the curbside program; distributed information; then asked residents to sign a pledge card to help determine program needs. Over half of the El Cerrito residents signed cards and monthly participation remained above 60 percent for over a year.(7)

Other methods: A variety of other methods have been used to promote recycling, with varying degrees of success. These methods include:

- Distributing program brochures, information flyers, door-hangers, mailings, and calendars;
- Advertising in the print and broadcast media;
- Preparing news releases, feature stories, and public-service announcements for media use;
- Establishing a telephone hot-line service;
- Installing a speakers bureau to present recycling to churches, schools, and community groups;
- Making presentations and setting up displays at community events, parades, and fairs; and
- Setting up special contests and awards to recognize recycling efforts.



17. What are the Bay Area markets for recyclable materials? Will these markets be able to absorb future recyclable quantities?

The Bay Area has a wide variety of processing and manufacturing firms available to buy secondary materials. These firms fall into three categories: processors or dealers, brokers, and end-user manufacturers. Dealers purchase recyclable materials, process them to consumer standards, and transport them to market. Brokers consolidate shipments from a variety of sources and provide manufacturing firms with a reliable supply of materials. End-user manufacturers buy the recyclable materials

to use in their manufacturing process instead of using raw materials. Once dealers and brokers buy materials (from the public and other sources), they sell these materials to end-user manufacturers.

Prices paid for recyclables, especially for bulk-grade papers such as newspaper and corrugated cartons, can fluctuate considerably. Aluminum prices also vary, but are very high relative to other recyclables' prices. Glass prices have been increasing slowly over the past five years and tend to be stable. The Bay Area has an advantage over many other regions in that large quantities of wastepaper and scrap metals are exported to the Pacific Rim countries. Export markets can in turn increase the volatility of market prices locally. As large orders from overseas mills stimulate aggressive buying on the West Coast, local prices for bulk grades such as corrugated and mixed waste paper often rise rapidly until the supply is met and then drift downward until a new buying cycle begins. (Market prices available for recycling programs in the Bay Area as of mid-1989 are shown in Table 17-1.)

Whether markets are capable of absorbing recyclables generated from new programs is a serious concern. While the goal of reducing waste has been a boon to the recycling industry in general, an imbalance between the traditional supply and demand forces for recycled materials is creating havoc in some regions of the country. Many states recognize the need to stimulate market demand, including California (see Sidebar 6.2). Some of the areas that will be investigated by the new California Integrated Waste Management Board include:

- Alternative available markets;
- Regional cooperative markets;
- Processing alternatives to access new markets;
- Pilot programs for new uses of recovered materials;
- Revision of procurement policies to encourage recycled content purchases; and
- Tax incentives to encourage recycling market development;

The availability of markets to purchase recycled materials is critical to the success of local recycling programs. Consequently, recycling planning will require closer attention to the role and vulnerability of markets as more recycling programs are implemented here and elsewhere during the next decade.

Table 17-1

Market Prices of Selected Recyclable Materials

Material	Price ($/ton)	Note
Aluminum cans	$1,140-$1,480	Baled and delivered to buyer's dock
Glass containers	$35-$80	High range for color sorted, delivered to buyer
Newspaper	$10-$40	High range for baled and delivered to buyer
Corrugated	$10-$62	High range for baled and delivered to buyer
Mixed wastepaper	$2-$21	Usually overseas markets for large quantities
Steel cans	$22-$40	Price for gross ton (2,240 lbs.), limited market

Source: BVA Telephone survey of Bay Area dealers and end-user markets, June 1989.

18.  **How important are ordinances in making a recycling program successful?**

Ordinances have been adopted in many local communities to support recycling activities. One of the most common ordinances in the Bay Area is known as the "anti-theft" or "antiscavenging" ordinance, designed to prevent people not working with the curbside collection program from taking recyclable materials placed at the curb and selling them to local dealers. Scavenging results in lost revenues for the curbside operations. While enforcing "anti-scavenger" ordinances is a low priority for police departments, the presence of such ordinances does deter theft of recyclables and helps define the curbside program as a public service.

Other legislation, known as "mandatory recycling" legislation, is employed in various parts of the country to mandate that the public recycle, or source-separate its waste for recycling purposes. A wide range of recycling legislation is being introduced every year, especially in regions most affected by the lack of adequate landfill capacity. The effectiveness of this type of legislation is still being assessed. Whether recycling programs are operated on a mandatory or voluntary basis, most recycling operators agree that public awareness about the "garbage crisis" and the benefits of recycling are essential to program success.

19. **How can a community realistically determine how much of its waste can be recycled?**

In passing AB 939, the state of California has outlined minimum goals for cities and counties.

A recycling goal should strike a balance between what is theoretically possible and what is readily attainable with current established practices. It can motivate a community to implement vigorous programs and increase its efforts to change wasteful practices.

In passing AB 939, the State of California has outlined minimum goals for cities and counties. AB 939 requires communities to meet waste diversion goals of 25 percent by 1995 and 50 percent by 2000. For most areas of the state, recycling will be the single most important means for meeting these goals. AB 939 requires that cities and counties develop a recycling component as part of their Source Reduction and Recycling Element (see Sidebar 6.1). In early 1990, the State established guidelines for development of the recycling component. Another major piece of recent legislation, SB 1322 by Senator Bergeson, specifies that the state establish a Recycling Market Development Commission and local recycling development zones that will be of help to local governments, among other programs.

To set realistic goals for recycling, several steps must be taken. The first step is to determine how much waste is generated. This involves identifying the sources of waste (residential, commercial, and industrial) and the amount of waste (tons per year) entering the waste stream from each source. Next, a waste composition study should be carried out using available data to determine the waste stream components. Recyclables such as newspaper, corrugated paper, glass, ferrous metals, aluminum, plastics, and yard waste can then be quantified based on the community's own waste stream.

After determining how much and what kind of waste is available for recycling, realistic goals for recycling can be determined by using projected participation rates and typical capture rates (i.e., the amount of recyclables a participant will actually separate for collection). Expecting that all of the recyclables in a waste stream will be recovered is unrealistic, since no program can attain either 100 percent participation or 100 percent recovery. Applying estimates for materials recovery based on actual program experience in other communities also may be unrealistic since program success can vary tremendously from community to community.

Benefits and Constraints

20. What are the benefits of recycling programs?

Recycling involves producing new commodities out of discarded materials. Some of the environmental and economic benefits realized through recycling are:

Energy savings: Manufacturing with recycled materials requires less energy than manufacturing using raw materials. Energy savings amount to 95 percent for aluminum cans, 34 percent for newspaper, and 24 percent for corrugated cartons. [8]

Conservation of natural resources: Recycling helps conserve our limited natural resources utilized in manufacturing products. Recycling one ton of newspaper, for example, saves 17 trees. Recycling also reduces our dependency on foreign oil and mineral imports.

Landfill capacity: Materials that are recycled do not need to be disposed of in a landfill. This means landfill life is extended and costs associated with waste collection and landfill operations are avoided.

Compatibility with waste-to-energy: Recycling is beneficial to waste-to-energy operations in a number of ways. For one thing, removing materials such as glass and metals results in less wear and tear on equipment, increases the overall energy value of the fuel by removing noncombustibles, and may reduce the amount and potential toxicity of

ash residue after incineration. Recycling at the "front-end" of a waste-to-energy facility also allows for recovery of valuable post-consumer materials that are readily marketable, such as metals, glass, some plastics and various grades of paper. These materials are usually unmarketable after incineration.

Economic alternatives: Recycling is highly cost-effective compared to traditional refuse collection and disposal. Curbside recycling programs, for example, often result in a net cost per household of less than $1 per month; or between 1 and 20 percent of conventional collection and disposal systems. Additionally, economic benefits of recycling include the creation of new jobs and economic development opportunities for emerging recycling businesses.

Hazardous materials management: Separating and/or recycling hazardous materials at their point of generation is more acceptable than incineration or landfilling.

21. What are some of the constraints of recycling?

There are a number of constraints to recycling, some of which can be overcome by good program design and planning.

Instability of markets: This is one of the most common reasons that recycling programs fail. Federal and state market development policies and initiatives are just beginning to address the need to create stronger recycling markets required to make recycling work. (See Sidebar 6.2.)

Lack of participation: Lack of participation can result in poor recovery volumes and can affect program economics. Providing effective public education and maximizing program convenience is often the key to getting individuals to participate.

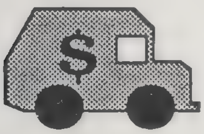
Technical constraints: For certain materials, such as plastic packaging, technical constraints of collecting and processing a variety of plastics in the waste stream has prompted significant research. As the waste stream composition changes over time, new technologies are needed for cost-effective collection, processing, and marketing of the materials targeted for recycling.

Institutional constraints: Many institutional constraints inhibit the development of recycling programs. For example, some communities do not distinguish recyclables from the regulated waste stream, thereby legally limiting the role of private (nonfranchised) and non-profit firms in providing recycling services. Restrictive flow control ordinances, used in support of waste-to-energy contracts, may also limit the amount of recyclables allowed to be removed from the waste stream. Zoning ordinances can confine all recycling facilities to industrial areas and could curtail the effectiveness of some types of recycling programs, such as

drop-off or buy-back centers. Federal tax policies and regulations favoring virgin materials over secondary or scrap materials also inhibit the growth of recycling. Oil depletion allowances, land subsidies for mining and timber operations, advantageous tax structuring and other incentives favoring the exploitation of our natural resources have resulted in a competitive disadvantage for the recycling industry. Only recently have state and federal legislatures begun addressing some of the institutional barriers to recycling by enacting laws favorable to the growth of recycling.

Environmental constraints: Recycling, like any other solid waste option, brings with it certain environmental impacts. Waste water contamination from the deinking process in paper mills is a potential environmental impact. Traffic and litter problems from a neighborhood buy-back center, and noise or visual impacts associated with a processing center are some of the environmental issues encountered by recycling operators. Good facility design and program planning can usually overcome such concerns, and help establish recycling as an environmentally sound and acceptable solid waste management option.

Economics



22. How much does a curbside collection program cost?

Curbside collection costs are broken into capital costs and operating costs. Capital costs cover equipment, facility construction, and household containers; and operating costs cover the collection, processing, and marketing of recyclables. Specific program features and local conditions will also affect the program costs. Those conditions include: the number of materials collected; the frequency of the collection service; the availability and stability of markets; the type and number of storage containers provided to residents; the degree of material processing required; and the level of public participation.

Costs: A representative survey of 19 curbside collection programs across the country revealed a wide range of both capital and operating costs in 1988.(9)

Capital costs for a curbside program include the purchase of trucks, processing and storage equipment, land, and facilities. Capital costs of the surveyed programs range from $10 to $150 per ton of material handled in 1988.(9)

Operating costs represent recurring program costs, including costs for collection, handling and processing labor; utilities; administration; and

promotion. Operating costs among the surveyed programs range from $46 to $227 per ton of material handled.

Revenues: The sources of revenue for a curbside program fall into five categories:

- Material sales — Sale of recyclable material to local markets represent about 45 percent of the average program's revenue.

The remaining 55 percent of program revenues come from four general revenue sources:

- Contract payments — payments made to the program operator to provide service.

- Grants — some state and regional governments provide grants for curbside collection.

- Tax and surcharge revenues — local government funds raised to subsidize the program.

- Waste diversion credit — revenue made available because recycling reduces public cost for garbage collection and landfilling.

Net cost: The net cost for curbside recycling programs in the Bay Area ranges from $0.45 to $1.25 per month per household serviced (as of 1989).[10] Depending on public participation, program features, and revenue from material sales, curbside collection costs are relatively consistent. Many communities feel these costs compare very favorably with the cost of collection and disposal of waste in Bay Area landfills.

COMPOSTING

Technologies

23. What are the major types of composting programs?

Composting is the biological decomposition of organic matter into humus suitable for use as a soil amendment or an intermediate, absorptive landfill cover. The three major types of composting programs are yard waste composting, MSW composting, and cocomposting of MSW with sewage treatment sludge.

To be effective, each of these programs must:

- Separate contaminants by manual or mechanical means;
- Grind or screen for particle size reduction; and
- Control moisture content, temperature, and the carbon/nitrogen rates to promote the activity of microorganisms that decompose the organic matter.

Yard waste composting: Yard waste consists of leaves, brush, tree trimmings, grass, and related materials generated by nurseries, landscapers, municipal programs, and individual citizens. Leaves make up the major waste material managed by many yard waste compost programs. Some programs provide a collection system, others accept yard waste brought by residents and generators to a centralized processing site. Most existing leaf composting operations around the country utilize the windrow method. This involves building elongated piles of compost material (windrows), periodically turning the piles, and controlling water and temperature levels. A simple windrow process typically creates a finished end-product in 12 to 24 months, depending on the methods used.(11) More rapid composting may be achieved using more advanced methods that provide ideal conditions for decomposition. Year-round temperate weather also speeds composting.

Composting of MSW: While relatively uncommon in United States, composting of municipal solid waste (MSW) is widely used for solid waste stabilization and disposal in many parts of the world. In assessing the potential for this type of program, consideration must be given to the diversity of the waste stream and the present cost and environmental issues related to their disposal. The basic steps for MSW composting are:

1) Preprocessing — includes size reduction of waste by shredding or grinding, materials separation to eliminate noncompostibles, and mixing to produce homogeneous feed materials;

2) Composting — utilizing one of four methods: windrow, dynamic bin, static pile, or in-vessel reactors to facilitate the composting activity; and

3) Postcomposting — the curing, separation, and grinding processes used to produce the finished product.

Cocomposting: Cocomposting refers to the simultaneous composting of two or more diverse waste streams. Usually the two streams are MSW and waste water treatment plant sludge or septage. Merging these two waste streams is beneficial because the high nitrogen content of the sludge adds to the value of the compost, while MSW serves as a carbon source for the sludge. Furthermore, the lower heavy metal content in the MSW can decrease the metal concentration in the final compost product.

24. To what degree are composting programs being implemented by communities in the United States and Europe?

Yard waste composting: The growing demand for landfill alternatives in this country is leading more communities to implement leaf and yard waste composting projects. By early 1989, there were approximately 900 yard waste composting facilities in the nation.(12) As more states ban the disposal of leaves and/or other yard wastes in landfills, the growth of yard waste composting is expected to rise rapidly. (Minnesota, New Jersey, Wisconsin, Illinois, and Pennsylvania have passed such laws.)

Composting of MSW: Composting of MSW is better established and more prevalent in Europe than in the United States. Facilities, many of them large scale, are operational in France, Germany, Italy, Switzerland, Belgium, Greece, and many other countries. At the end of 1988, there were four MSW composting facilities operating in the United States two of which were cocomposting MSW with sewage sludge. Another 30 communities were either considering, designing, or constructing an MSW composting project.(12) MSW composting programs are expected to grow in this country, as the pressure to divert materials from landfills increases.

Cocomposting: Cocomposting of MSW and sewage sludge also experienced rapid expansion during the 1980's. In 1983, there were approximately 60 such facilities in the United States. A 1988 survey revealed 114 operating sludge composting facilities, with another 105 in the planning, design, or construction phase.(12)

Benefits and Constraints

25. What are the benefits of a composting program?

The composting of MSW components, such as food waste, yard waste, paper, and other miscellaneous organics, provides a number of benefits. These are detailed below.

Environmental protection: Composting provides an environmentally sound method of waste disposal because it relies on natural biological processes under controlled conditions. Assuming the level of heavy metals in the compost are negligible or low, land, water, and air pollutants are minimal.

Volume reduction: Composting can reduce the volume of materials by 30 to 60 percent.(13) This is especially significant since yard waste in many communities comprises 15 to 30 percent of the waste stream, and extending landfill capacity is a high priority.

Conservation of resources: Composting targets the organic fraction of the waste stream as a resource, rather than a waste disposal problem. Natural resources such as plant nutrients and organic matter are reserved for future use through the composting process.

Production of usable materials: Depending upon the level of processing applied, composting programs can produce a wide variety of stable products that can be used as a ground cover, a mulching material, or a soil amendment.

Landfill compatibility: Composting facilities are often established at landfills in order to produce an inexpensive cover material that can be used on-site. The compost provides a layer of vegetative material or mulch that lies on top of the final cover material when a landfill is permanently closed and capped. This alternative use of a portion of the waste stream to produce cover material often eliminates the need to haul soil onto a landfill during the closure phase of landfill operations.

26. What are the major constraints of successfully operating a composting program?

Many obstacles may be encountered when establishing a composting program, depending on the type of project and scale of operation planned. In general, because of their size and the variety of refuse materials, MSW composting facilities will face more siting restrictions and raise more environmental concerns than yard waste composting programs. Four constraints common to composting programs are discussed below.

Land availability: In highly populated areas such as the Bay Area, the availability of land for composting may be limited and expensive. This may require making a large capital investment before an operation can begin. One alternative often used is to locate composting facilities on existing landfill sites, or on public lands dedicated to waste management-related operations.

Siting constraints: Siting composting facilities can be difficult, due to environmental, health, and economic concerns. This is especially true if local jurisdictions treat composting activities the same as other waste management activities (i.e., landfills, transfer stations, waste-to-energy, or other facilities). Special requirements for controlling potential odor, noise, visual, and dust impacts, may emerge during the permitting process, as well as the need for substantial design modifications. Lack of state, federal, and local standards for permitting composting facilities and product uses is an ongoing concern for composting proponents.

Lack of product markets and utilization: The reasons for implementing composting programs, as well as the technologies used, vary from community to community. A composting program may be implemented

for landfill diversion, sludge treatment, or high-quality product development. The methods employed may include yard waste composting, cocomposting of sludge, leaf composting, and MSW composting. Either way, the end-product will require a specific use or market for the program to succeed. Identifying reliable markets and assuring that the processing system is capable of meeting the market specifications is essential for a successful composting program. Successful marketing of a compost product is not always feasible until the end-product is tested. Attention to potential market requirements and feasibility in the system so that it can be modified to produce marketable materials should be included in the program design.

Material contamination and health concerns: The composting process can cause health risks, due to the levels of trace metals, toxic chemicals, or pathogenic microorganisms found in the end-product. Therefore, care must be taken to ensure proper compost management during the process. Quality control and end-product monitoring are likely to be more necessary and expensive to maintain if the compost products will be applied to food crops. Compost products intended for landfill covering or mulching materials are not likely to pose as great a health risk.

Economics

27. $ What does a composting program cost?

A number of factors have to be considered when determining the cost of a composting program. Often the amount of land, labor, and capital available will determine the composting technology employed by a community. At minimum, if a community has no available land and minimal capital to invest, it can nevertheless encourage residents to compost in their backyards, via public education and technical assistance (e.g. brochures). More ambitious yard waste compost projects may provide periodic or regular collections, storage containers for residents, and a sophisticated processing facility. Such a project would produce a quality compost product. This requires extensive capital for site development, equipment, promotion, management, and marketing. As backyard composting is the least expensive method from a community standpoint, and helps develop environmental awareness, it should be encouraged in communities that also adopt a centralized system.

In general, the collection and transportation costs for a yard waste composting program are much higher than the processing costs. A recent EPA survey of eight programs nationwide found the ratio of collection and transport costs to process costs ranged from 1:1 to 11:1. The same survey found the total cost per ton for producing a composted end-product ranged from \$11 to \$102.[14]

Composting program costs should be viewed in the context of a costs/benefits analysis. Costs associated with initial capital investments, and ongoing operations and maintenance (or payments to a private contractor) can be balanced against the received revenues or avoided costs associated with selling or using the compost. In addition, the most significant community benefit from composting is often the diversion of substantial volumes from the waste stream, and consequent extension of landfill capacity.

Municipal solid waste composting facilities designed for large-scale processing capacity have by far the highest capital and operating costs (millions of dollars) of the three composting program types. MSW and sludge cocomposting programs, especially those using in-vessel systems, tend to have the highest per ton cost for finished compost product, ranging from $100 to $400 per ton. Yard waste and leaf composting programs with home collection service may range in costs from $.50 to $2.00 per household per month.

WASTE-TO-ENERGY

Technologies

28. What are the major waste-to-energy technologies?

Three primary technologies have emerged in the United States for converting MSW into energy. They are mass-burn combustion systems, materials recovery/refuse-derived fuel (RDF) combustion systems, and modular systems.

Mass burning: Mass-burning systems process MSW "as is," generally with no sizing, shredding, or separating prior to burning. Usually, the only preprocessing involved in mass burning systems is the removal of large bulky items and/or hazardous materials from the waste feed stream. The heat energy released during the combustion of the waste materials creates steam, which is used to produce energy. The steam can be used to power a turbine, which generates electric power, and/or it can be sold to industrial/institutional customers for heating and processing. Mass-burning facilities can process 100 to 3,000 tons of waste per day.[15] These systems have to be erected on-site, which is more expensive than modular (prefabricated) units, but the plants last longer and are more thermally efficient.

Refuse-derived fuel (RDF): The refuse-derived fuel process utilizes a two-part production-incineration system. Refuse-derived fuel is the combustible portion of solid waste, which is separated from the noncombustible portion through processes such as shredding, screening, and air classifying. What results is a relatively homogeneous product, which can be burned in a boiler located on-site or marketed as a fuel to outside users (utilities or industries). In general, RDF systems must be large to achieve the economies of scale necessary to pay the additional cost of front-end processing equipment. While systems of less than 1,000 TPD exist, the majority of systems are over 1,000 TPD.[15]

Modular systems: Modular systems are similar to mass-burning plants, but are usually smaller in size. These plants are often prefabricated and can be quickly assembled on location. Modular systems can process waste quantities in the range of 5 to 150 tons per day. When multiple units are used, modular systems can reach capacities of up to 600 tons per day.

SIDEBAR 28.1

NONTRADITIONAL WTE SYSTEMS

Waste-to-energy technologies continue to evolve. New and nontraditional technologies exist, in various stages of development, and many offer potential advantages over the aforementioned traditional technologies. Some are currently used to process hazardous, septic, and other problem wastes, and are being considered for use on MSW. These technologies, discussed below, have not been adequately demonstrated and are not commercially available at the present time.

Fluidized bed reactor: Fluidized bed combustion has been successfully applied to many fuels, but has not handled much MSW. This system burns solid fuels more cleanly and efficiently than conventional boilers. A noncombustible material is used in the furnace as a substitute for a grate to help combustion. The bed material is heated and circulated in the combustion system, allowing for direct contact with the waste. The heat is recovered from the exhaust gases and the inert material is recycled.

Pyrolysis: In this procedure, waste is exposed to high temperatures in an oxygen-free atmosphere and chemically decomposed. In general, MSW is processed to produce a uniform material and is then heated to remove water before being fed into the pyrolysis chamber. The process reduces the solid waste to three forms: gas (hydrogen, methane, carbon monoxide, and carbon dioxide), liquid (water and organic chemicals), and solids (carbonaceous char). The gas is collected and some is used as fuel for pyrolysis, with surplus gas available for sale as an energy source.

Anaerobic digestion: Under this process, MSW is processed, mixed with sewage sludge, and held in a digester tank without oxygen for a period of days. During this time, cultured microbes digest the slurry, giving off methane and carbon dioxide. The digestion residue is dewatered and landfilled, or it is dewatered and burned to achieve maximal waste reduction and power production.

FIGURE 28-1
CROSS-SECTION OF MASS-BURN PLANT

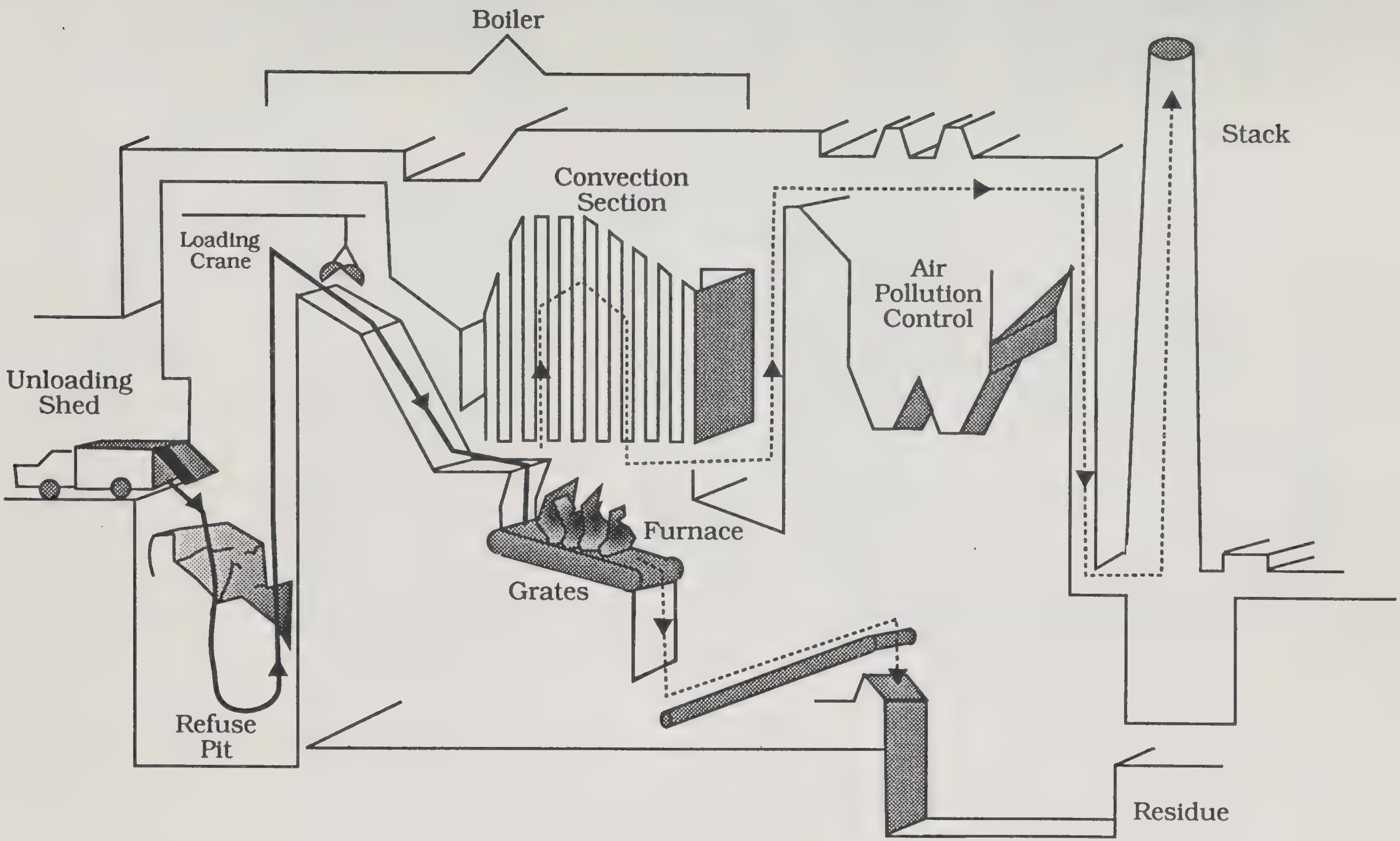
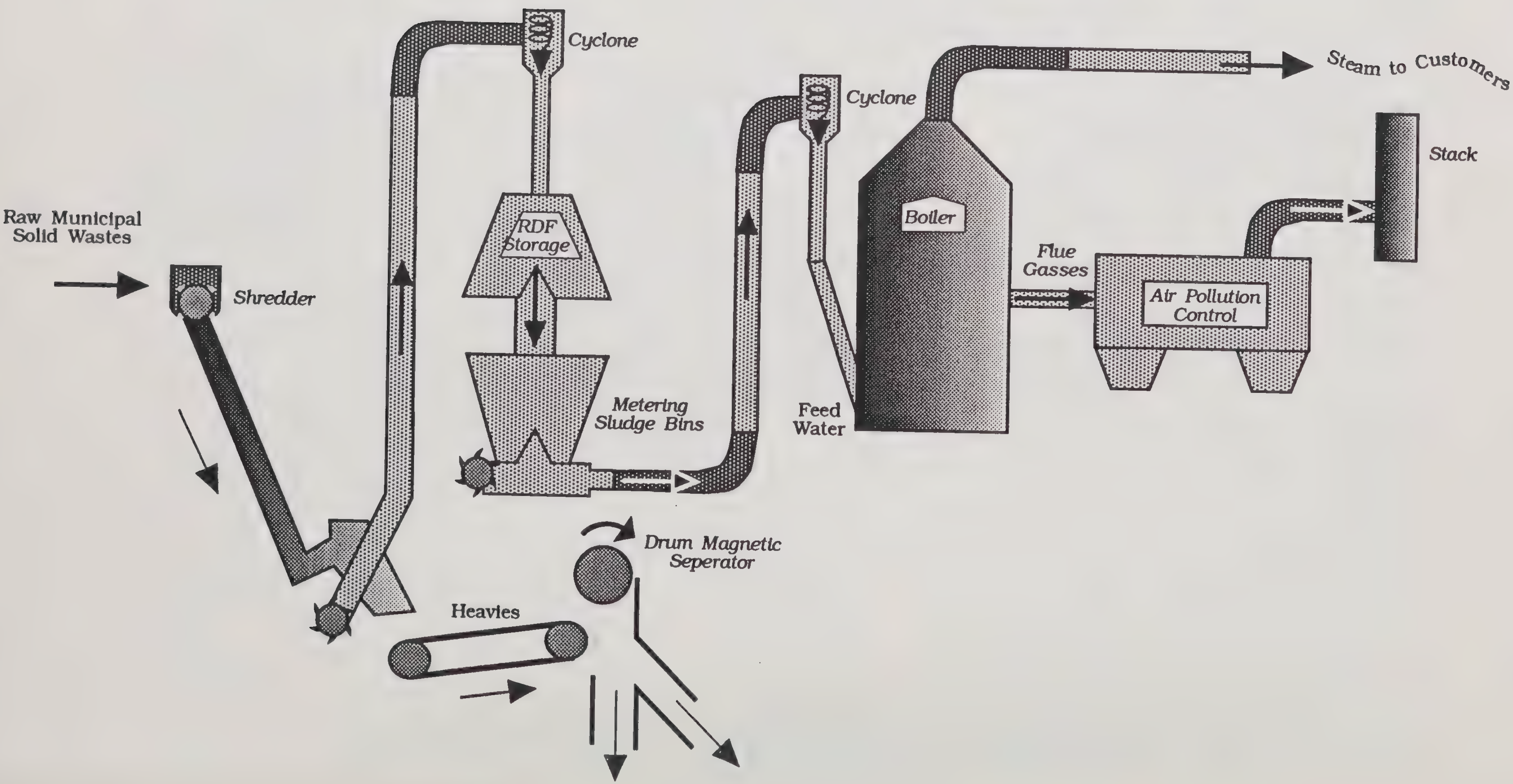


Figure 28-2
Refused Derived Fuel System



SIDEBAR 28.2

BIOMASS WTE SYSTEMS

Urban wood waste: The use of biomass, particularly wood waste, represents an important aspect of the waste-to-energy industry. The forest products industry has long been involved in the use of wood residue to meet their energy needs. More recently, the recovery and combustion of urban wood waste from such sources as wood products manufacturers, landscapers, pallet users, and the construction and demolition industry has become more prevalent. This upsurge has been driven by communities' need to reduce their solid waste stream.

This is particularly true in the Bay Area, where existing and planned capacity for the production of hog fuel from urban wood waste has increased significantly in recent years. This upsurge in production has occurred in conjunction with increased development of biomass power plants throughout the state. There are currently several dozen such plants operating, including a pulp mill operation in Antioch.

In addition to these biomass facilities there is a tire burning facility in Antioch and various other non-traditional waste-to-energy facilities operating in California that burn materials such as coal waste fires and petroleum coke.

29. What is the track record of WTE facilities across the country?

As of July 1989, 122 WTE facilities were operating in 36 states across the country. About 47 percent of the 68,000 tons of garbage processed everyday by WTE plants is done through mass-burn technology, with 34 percent and 18 percent using modular and RDF technologies, respectively (Figure 29-1).[15] The majority of WTE facilities in the country are located in the Northeast, since landfill shortages there have been particularly acute over the past 15 years. A large number of facilities are also located in the South. The western United States has relatively few WTE facilities. Currently, only three WTE facilities burn MSW in California — Stanislaus County, The City of Long Beach, and the City of Commerce. (See Figure 29-2.)[16]

In the 1970's, WTE projects in the United States ran into problems. Although mass-burn systems were based on established European technology, MSW quantities were much larger in the United States than in European cities. The composition of the United States waste streams were vastly different than Europe, and there was an incomplete transfer of technical and operational experience between the two continents. Likewise, the reliability of early RDF facilities was not high, because these

systems had complex materials handling and processing equipment that often broke down.

Since the mid-1980's, well-capitalized, publicly and privately owned WTE firms have developed a series of successful and reliable mass-burn, RDF, and modular WTE facilities. At the same time, local governments have become more knowledgeable about WTE facilities, realizing the importance of an integrated waste management plan that includes waste reduction, recycling, composting, and landfilling.

30. What are the considerations in constructing and operating a WTE facility?

Before deciding whether to construct and operate a WTE facility, a community should first determine if the project is needed, and then carry out a thorough technical, environmental, and economic evaluation.

To decide if they need a WTE project, a community should determine when its existing landfill capacity will be depleted. It should next assess the likelihood of securing long-term landfill capacity in the future and the projected costs of landfill disposal. The analysis should also include calculations on current and future landfilling rates (including anticipated recycling), disposal fees (including ash disposal), local business fees, and transportation costs. In addition, the needs analysis should review the availability, effectiveness, and cost of landfill alternatives, such as source reduction, recycling, composting, and materials recovery programs.

Once it decides that a WTE project might be feasible, a community should evaluate the facility from three standpoints:

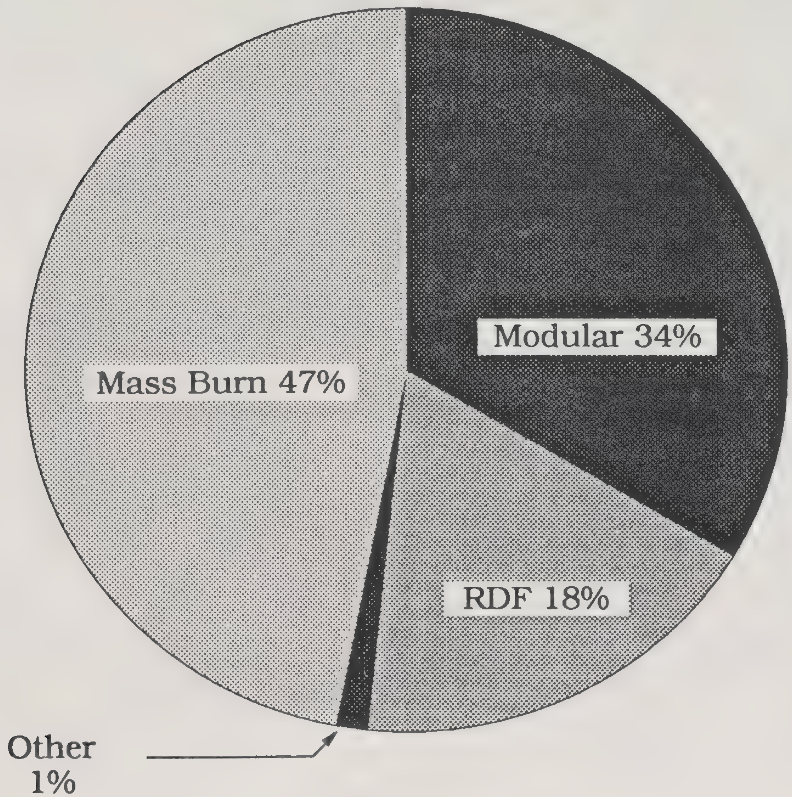
- Technical: What are the major commercially available technologies? What is the track record of these technologies? Which technologies are best suited for a particular community?

- Environmental: What are the potential environmental consequences of a WTE facility? What methods can be used to mitigate them? How do these impacts compare to the environmental impacts of other options?

- Economic: How much does a WTE facility cost to construct, operate, and maintain? What are the financing mechanisms available? How does this compare to other waste management options? What are the economic risks of the project? Is there enough waste over a 20-year period (considering the 50 percent diversion requirement) to sustain the project? Can this waste be committed to the project over a 20-year period?

Figure
29-1

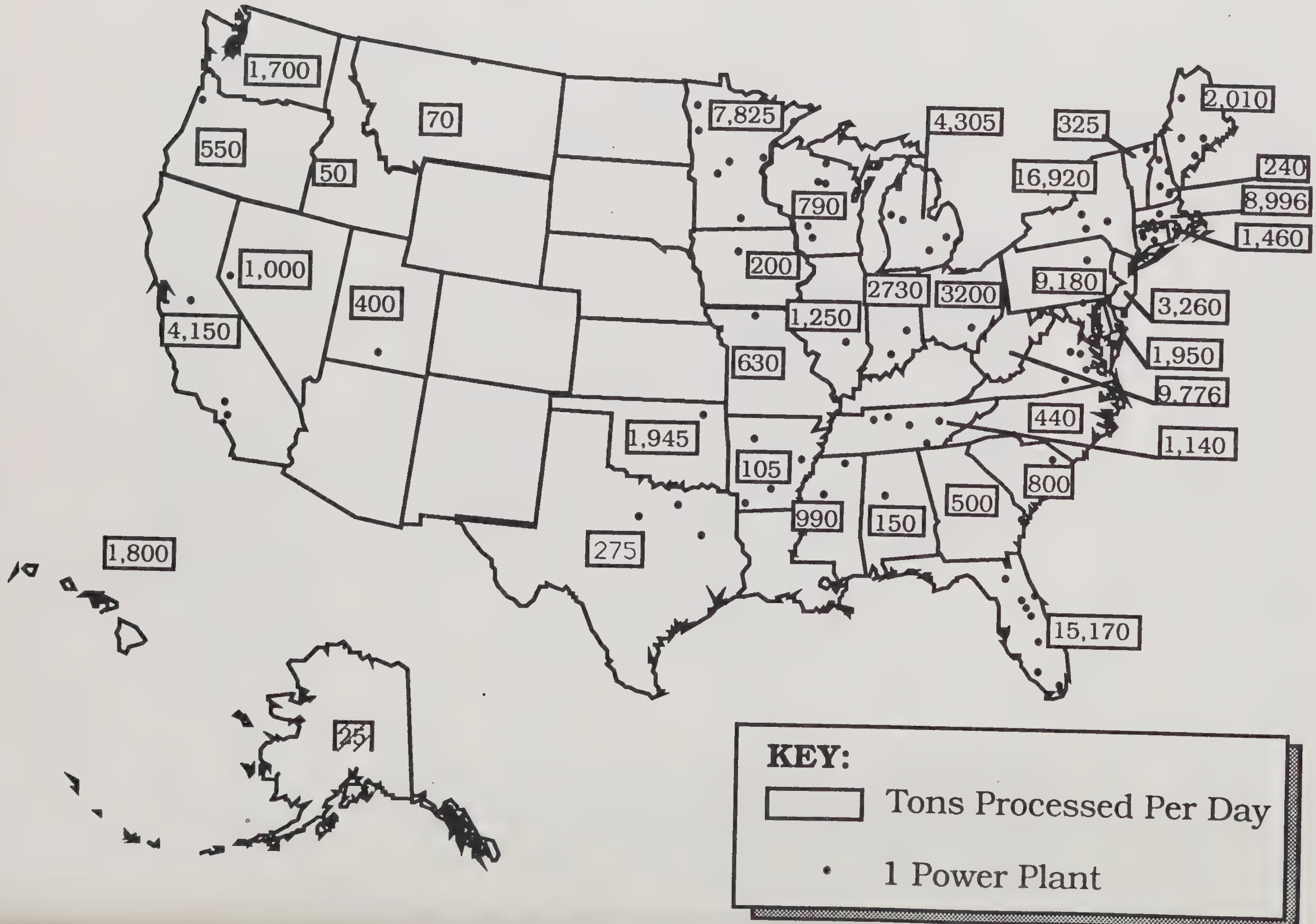
Distribution of Existing Installed Municipal Waste Combustion Capacity by Design Type



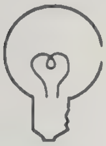
Total Design Capacity = 56,005 Tons per Day

Source: "Special Report: Resource Recovery in the United States," National Solid Wastes Management Association, September 1, 1989.

Figure 29-2
United States Waste to Energy Facilities



Energy Markets



31. What kinds of energy can be produced by WTE facilities?

Electricity and steam are the two primary forms of energy produced by WTE facilities. In WTE facilities, electricity is usually produced by the following "combustion-generation" process. Waste is fed into a boiler and combusted. This heats water flowing through tubes in the boiler to produce high pressure steam. The energy in the steam is then used to rotate a turbine, which is coupled to a generator. When rotated, this generator produces electricity.

Most of the electricity produced is sold to a utility, with the facility retaining a small amount on-site to meets its own needs. If steam is produced by a WTE facility, it may be sold to a nearby steam user(which could be a large industrial steam user), or converted to electricity and sold to a utility company, or both. The thermal host must be located near the WTE facility since a lot of thermal energy is lost in the transmission of steam. Most WTE facilities only generate electricity.

32. Does an electric utility have to purchase power produced by a WTE facility?

Yes. In 1978, the United States Public Utility Regulatory Policies Act (PURPA) was established to promote the use of renewable resources in electric power production facilities. PURPA guidelines require electric utilities to purchase electricity from "qualifying" cogeneration and small power production facilities, including "qualifying" WTE facilities. A WTE facility qualifies by meeting certain PURPA efficiency criteria. The PURPA criteria for a solid waste resource recovery facility state that it must produce less than 80 MW of electricity, and at least 75 percent of the fuel must be solid waste, biomass, renewable, or geothermal resources. The annual consumption of natural gas, oil, and/or coal may not exceed 25 percent of the total energy input in any calendar year.

In order to facilitate the development of such projects in California, the state PUC developed a series of standard offers (contracts) between the small power producers and the Electric utilities. These contracts provided for long-term (10 year) energy payment schedules, which greatly enhanced the ability of independent power projects to gain financing. Most of Standard Offer agreements were discontinued in 1985.

33.  **What factors determine the energy prices paid to WTE facilities?**

Electrical energy prices paid to WTE facilities are usually based on "avoided cost," which is defined as the cost the utility would otherwise incur to obtain or produce power. Avoided cost calculations are usually divided into two components: energy payments and capacity payments. Energy payments are based on the actual amount of energy transmitted to the utility, while capacity payments are based on the instantaneous amount of capacity made available to the utility for use. Avoided cost for energy is the utility's overall cost of generation, including the fuel used to generate electricity, the efficiency of the utility, and its incurred operation and maintenance costs. Avoided costs for capacity is the cost the utility avoids in purchasing or constructing an equivalent amount of capacity.

Fuel costs and operation and maintenance that the utility incurs are often the most costly components in the "avoided cost" calculation.

Most WTE facilities have fixed long-term contracts of 20 years or more with utilities, for energy and/or capacity payments. Utilities use their predictions of future avoided costs to formulate the contract. The avoided costs are reasonably stable and reliable for the term of the contract.

Air Emissions/Toxics

34.  **What are the air emissions from a WTE facility?**

Air pollutant emissions from waste-to-energy facilities are influenced by several factors. These factors include the types of combustion devices used and their operating features; composition of the solid waste and the degree of preprocessing; and methods used for and efficiency of air pollution control.

The primary air pollutants emitted from waste-to-energy facilities can include:

- "Criteria pollutants" (pollutants for which regulators have established air quality criteria, such as: particulate matter, nitrogen oxides, sulfur dioxide, and carbon monoxide)

- Acid gases (e.g., hydrochloric, hydrofluoric, and sulfuric acids)
- Heavy metals (e.g., chromium, cadmium, and lead)
- Toxic organic pollutants (e.g., aromatics, dioxins, other chlorinated hydrocarbons)

Table 34-1 lists the potential pollutants from municipal solid waste combustors. Table 34-2 provides a summary of emission ranges for selected air pollutants. Data are provided for two basic types of combustors: mass burn and refuse-derived fuel (RDF) fired. The EPA study data are based on air emissions at more than 50 municipal solid waste combustors in the United States, Canada, Japan, and Europe.(17) The wide range in emissions for many of the pollutants is due for the most part to widely varying air pollution control devices. Newer facilities, especially in California, must install efficient particulate and gas scrubbing control devices. Average emissions from two newer plants are also given in Table 34-2.

The use of presorted MSW fuel can reduce flue gas and heavy metal emissions, and increase combustor efficiency. A recent study of three mass-burn incinerators (18) — each using MSW fuel from which aluminum and ferrous metals, glass/grit, and batteries had been removed — showed substantial decreases (25 to 60 percent) in emissions of lead, cadmium, mercury, tin, zinc, and arsenic.(18) Acid gases and other gaseous pollutants (e.g., CO, HF, HCl, and NO_x) were also reduced (40 to 80 percent).

Table 34-1

LIST OF MAJOR AIR POLLUTANTS FROM MUNICIPAL SOLID WASTE COMBUSTORS

Criteria Pollutants	Toxic Organic Pollutants
Particulate matter (PM)	Polychlorinated dibenzo-p-dioxins (PCDDs)
Nitrogen oxides (NO_x)	Polychlorinated dibenzofurans (PCDFs)
Sulfur dioxide (SO_2)	
Carbon monoxide (CO)	
	Polycyclic aromatic hydrocarbons (PAHs)
Acid Gases	Tetrachlorodibenzo-p-dioxin (TCDD)
Sulfuric acid (SO_3 or H_2SO_4)	Tetrachlorodibenzofuran (TCDF)
Hydrochloric acid (HC1)	
Hydrofluoric acid (HF)	Benzene
	Chlorinated benzenes (ClB)
Metals	Chlorinated phenols (ClP)
Arsenic (As)	Polychlorinated biphenols (PCBs)
Beryllium (Be)	Formaldehyde
Cadmium (Cd)	Vinyl chloride
Chromium (Cr)	Benzo-a-pyrene (BaP)
Lead (Pb)	
Mercury (Hg)	
Nickel (Ni)	

Source: EPA (1987)

Table 34-2
SUMMARY OF WASTE-TO-ENERGY COMBUSTOR AIR EMISSION[a]

	Range in EPA —MSWC Study[b]		Newer Combustors[c]	
	Mass burn	RDF-fired	Conn.	California
PM, gr/dscf	0.002-0.669	0.096-0.233	0.006	0.011
SO_2, ppmdv	0.040-401	54.7-188	4.3	4.1
NO_x, ppmdv	39-376	263[d]	184	103
CO, ppmdv	18.5-1,350	217-430	188	43
As, ug/Nm^3	0.452-233	19.1-160	<2.9	0.77
Be, ug/Nm^3	0.0005-0.327	20.6[d]	<0.76	<0.00054
Cd, ug/Nm^3	6.22-500	33.7-373	—	2.1
Cr, ug/Nm^3	21.3-1,020	493-6,660	<45.0	12.0
Pb, ug/Nm^3	25.1-15,400	973-9,600	<20.0	—
Hg, ug/Nm^3	8.69-2,210	170-441	24.0	—
Ni, ug/Nm^3	227-476	128-3,590	213.0	22.2
2,3,7,8-TCDD, ng/Nm^3	0.018-62.5	0.522-14.6	—	—
2,3,7,8-TCDF, ng/Nm^3	0.168-448	2.69[d]	—	—
TCDD[e] ug/Nm^3	0.195-1,160	3.47-258	0.03	—
TCDF[e] ug/Nm^3	0.322-4,560	31.7-679	—	—
PCDD[e] ug/Nm^3	1.13-10,700	53.7-2,840	—	6.92[f]
PCDF[e] ug/Nm^3	0.423-14,800	135-9,110	—	6.92[f]
HCl	7.5-477	95.9-776	2.0	1.28
HF, ppmdv	0.620-7.21	2.12[d]	—	—
SO_3, ppmdv	3.96-44.5			—

a) All concentrations are reported in units corrected to 12 percent CO_2.

b) From an EPA international survey on municipal waste combustors (EPA, 1987).

c) Connecticut combustor, an RDF facility, is Connecticut Resources Recovery Mid-Connecticut Project (19) and California combustor,a mass-burn facility, is Crows Landing Resource Recovery Facility (20).

d) Data are available for only one test.

e) For the chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans, data are presented for all homologue groups (PCDD and PCDF), for the "tetra" group (TCDD and TCDF), and for specific isomers of the "tetra" group with chlorine substituted in the 2, 3, 7, and 8 positions (considered the most toxic).

f) Total concentration for both PCDD and PCDF.

Health Effects

35. What are the potential human health concerns associated with emission of pollutants from WTE facilities?

The potential effects of exposure to pollutants from a WTE facility may consist of: 1)short-term (acute) effects immediately following exposure at relatively high levels; and 2) long-term (chronic) delayed effects following exposure at relatively low levels. The possible effects can be further categorized as carcinogenic or noncarcinogenic, depending on whether the pollutants can cause cancer.

Carcinogenic health effects: The development of cancer after exposure to pollutants is not completely understood. Scientists believe that there may be a probability of developing cancer (however slight) from every exposure to a cancer-causing substance. Cancer-causing pollutants include arsenic, beryllium, cadmium, chromium, nickel, and some chlorinated hydrocarbons.

When evaluating a source of air pollutants, such as a WTE facility, the estimated cancer risk is expressed as the probability of one additional cancer case being developed due to exposure. It is important that conservative assumptions are used in estimating the cancer risk so that the risk, is not underestimated due to the incomplete understanding of cancer and its causes.

Since it is presently assumed that there is some risk of developing cancer from exposure to any concentration of a cancer-causing agent, there are no established safe levels of public exposure set as air quality standards for cancer-causing pollutants.

Noncancer health effects: Noncancer human health effects on organs or organ systems generally occur following exposure to pollutants above prescribed threshold levels. These health effects may include: skin irritation; respiratory problems; kidney, liver and cardiovascular problems; and reproductive and central nervous system effects. Some of the pollutants of potential concern are nitrogen oxides, sulfur oxides, lead, mercury, nickel, and some chlorinated hydrocarbons. Emissions from a WTE facility are added to existing background pollutant levels when assessing noncancer health effects.

Air quality standards for the major pollutants associated with combustion (criteria pollutants) have been established. These are considered safe public exposure levels below which no significant adverse health effects should occur, even among the most sensitive members of the population.

Exposure pathways: Exposure to pollutants through contaminated air is recognized as the most significant mode of public exposure to most of the pollutants from WTE facilities. There are, however, additional pathways of concern. For example, particulate matter in WTE air emissions could deposit into surface water or on land. These WTE pollutants, through bioaccumulation in fish or vegetative uptake, could enter the food chain. Table 35-1 lists some of the additional exposure pathways. The importance of each pathway would depend on site-specific characteristics such as land use patterns and water supplies. In estimating potential human exposure levels, it is important to consider the environmental fate of each pollutant, from the point of emission until contact with humans.

Table 35-1

POTENTIAL EXPOSURE PATHWAYS

Route	Source	Medium
Inhalation Ambient	Air Ambient	
Ingestion	Drinking Water	Surface Ground
	Food Chain	Crops Dairy Meat Fish Wildlife Maternal milk
	Pica Uptake	Dust and dirt
Dermal Absorption	Direct Contact	Air Soil Water

Source: Woodward-Clyde Consultants, 1989.

36. How are the potential community health risks from a WTE facility evaluated?

The potential health risks from a proposed WTE facility are evaluated by conducting a general health effects assessment, as required by California law. Both potential cancer and noncancer health effects are evaluated to determine the levels at which they may affect public health. At a minimum, this assessment consists of the following four steps:

1.) Hazard identification: The determination of the types of health effects that may result from exposure to the emitted pollutants.

2.) Dose response assessment: The determination of how these effects relate to exposure to these pollutants.

3.) Exposure assessment: The determination of the extent of potential exposure through all applicable environmental pathways.

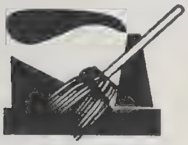
4.) Risk characterization: A description of the nature and magnitude of the human health risks that could result from exposure to pollutants from the facility.

The one-in-a-million ($1x10^{-6}$) excess individual lifetime risk level is presently considered acceptable for cancer risks associated with involuntary public exposure to cancer-causing pollutants. The risk estimate developed for a proposed WTE facility could be compared with the one-in-a-million risk level when considering whether a proposed facility poses a significant threat to the public health. Because of the limited knowledge about health effects and the conservatism in health risk estimates, it should be noted that a calculated risk above the one-in-a-million level does not necessarily suggest that decision makers should reject a proposed facility. The risk estimate can help determine the need for additional air pollution control devices or design modifications and methods of operation that would reduce the potential risk.

If projected ambient concentrations of noncancer-causing pollutants are above established threshold levels, mitigation measures need to be applied. These measures could include emission offsets (as described in Question 39), installation of additional air pollution control equipment, or modification of methods of operation.

The decision maker can use the results of health effects assessments not as absolute measures of actual risk, but in comparing available waste disposal options. This would help them identify the best set of options for handling waste in an environmentally sound manner.

Air Pollution Control Technologies

37. 

What air pollution technologies and strategies are available to protect air and human health?

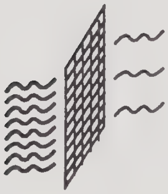
Aside from removing certain waste stream components prior to burning, air emissions from municipal waste combustors are controlled by the application of Best Available Control Technology (BACT) as required by regulatory agencies (see Sidebar 38). BACT involves the use of combustion control measures, as well as postcombustion control technologies (Figure 37-1).

Combustion control: Combustion control involves altering the combustion process to reduce emissions. The basic strategy of combustion control is to provide a combustion environment that will maximize the conversion of organic matter in solid waste to carbon dioxide and water, thereby reducing the discharge of gaseous organic materials. Examples of combustion control include burning MSW at high temperatures with sufficient oxygen, using combustion grates that maximize complete burning of MSW, and leaving MSW in the furnace for appropriate time periods.

Postcombustion control: Postcombustion control involves adding pollution-control equipment to clean the combustion gases. The most common postcombustion control technique involves the use of dry scrubbers in conjunction with a fabric filter (baghouse). Dry scrubbers remove acid gases through a chemical reaction using a lime slurry, which produces a dry powder. Some of this powder is collected at the bottom of the scrubber. The rest, along with the fly ash, is collected in the downstream baghouse. Ammonia injection is also sometimes used to treat acid gas streams. Baghouses operate like a vacuum cleaner; the flue gases are passed through a dense fabric, which filters particles from the gas stream. Other particulate control methods include electrostatic precipitators (ESPs), which trap particulate matter in electric fields, and wet scrubbers, which absorb acid gases and particulate matter in liquid. The main advantage of the dry scrubber/baghouse system over other forms of pollution control is high collection efficiency combined with a dry, rather than wet, waste product. Fabric filters are also more efficient in removing smaller particles (less that 10 micrometers) than other particulate removal devices. This is important since heavy metals, dioxins, furans, and other organics are preferentially absorbed onto smaller particles.

In developing an overall control strategy, it must be noted that application of a particular technology for one pollutant may have positive

or negative effects on the control of other pollutants. In addition, the increased capture rates of certain pollutants in the flue gases, particularly heavy metals, will increase their concentration in the fly ash. These and other issues are ordinarily handled during the permitting process by the regulatory agencies.



38. How effective are these technologies in controlling air emissions?

Anytime anything is burned, air emissions are created. Furthermore, no air pollution control technology or combination of technologies can eliminate all air emissions. However, by using the BACT and by properly designing and operating the combustion system, WTE facilities can comply with all current federal, state, and local air emissions limits for criteria pollutants (e.g., sulfur dioxide, nitrogen oxides). Although there are no specific emissions limits for noncriteria pollutants (e.g., dioxins, furans), current air pollution control technologies, in addition to proper combustion controls, can also minimize the majority of these emissions. However, the impact from these emissions needs to be determined.

SIDEBAR 38

BEST AVAILABLE CONTROL TECHNOLOGY

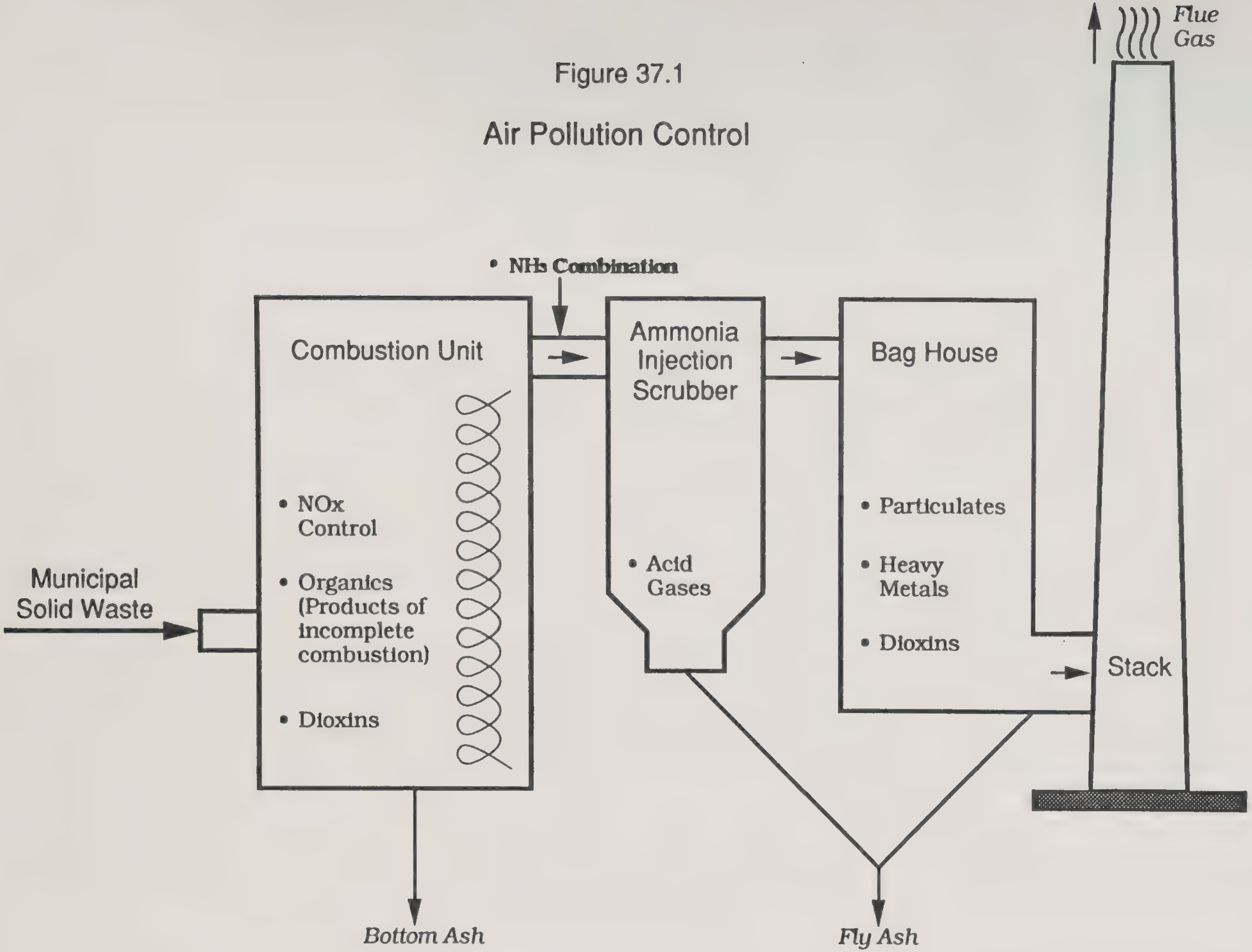
All proposed WTE facilities are required by federal, state, and local laws to use the BACT to control emission levels of a particular pollutant. The requirement for BACT is applicable when the estimated emissions of a particular pollutant exceed a specified "trigger level" in terms of pounds per day or tons per year. These trigger levels are listed in the air district's regulations.

BACT for a proposed project is evaluated on a case-by-case basis and reflects the current level and feasibility of air pollution control technology. BACT can be a particular piece of equipment, a specific emission limit, a fuel modification, or a percent reduction of emissions. BACT requirements are updated as new air pollution control techniques are developed.

Table 38-1 delineates emission limits and types of controls that have been used to meet current BACT limits.

Figure 37.1

Air Pollution Control



Source: Brown, Vence and Associates, 1989

Table 38-1

Emissions Limits and Air Pollution Equipment for Selected Pollutants

Pollutant	Emission Limit[a]	Air Pollution Equipment
Nitrogen oxides	120-180 ppm	Ammonia injection or selective catalytic reduction
Sulfur dioxide	30 ppm	Scrubber
Carbon monoxide	50-100 ppm	Combustion controls
Particulates	0.01 grains/dscf	Baghouse
Hydrocarbons	5 ppm	Combustion controls
Hydrochloric acid	30 ppm	Scrubber
Dioxins	n/a	Baghouse or combustion controls

Source: BAAQMD, 1989.

[a] 12 percent CO_2 correction.

Air Quality Management

39. How can the increase in air pollution from a WTE facility be mitigated?

Local air districts have rules and regulations that require using various equipment and processes to reduce air pollution. These rules and regulations are all part of the state implementation plan (SIP), a body of regulations, plans, and commitments the state has compiled. The purpose of the SIP is to control emissions in order to attain and maintain national ambient air quality standards. The U.S. Environmental Protection Agency requires all states to submit SIPs to them for approval. The SIPs are updated on an as-needed or as-required basis to reflect new regulations, plans, or commitments.

In implementing the SIP, local air districts routinely require project applicants to install air pollution control equipment to decrease the level of certain pollutants. In many cases, as with waste-to-energy facilities, local air districts require the use of BACT to reduce air emissions.

If air emissions are sufficiently large in areas already in violation of ambient air quality standards, project applicants are also required to obtain additional air emission decreases, also known as "offsets" (see Sidebar 39). Offsets are actual emission reductions that are over and above the reductions obtained from pollution control at the facility. For example, if a proposed resource recovery facility needed offsets, it could put air pollution controls on one or more pieces of equipment from nearby industries (not necessarily owned by the applicant) to reduce the total level of pollution. If these controls are installed and operated properly, they can make contributions to cleaner air that are over and above what would have been the case if the resource recovery plant had not been built. Offsets are required only for criteria air pollutants (nitrogen oxides, particulate, sulfur dioxide, carbon monoxide, hydrocarbons). For noncriteria (toxic) pollutants, emissions from WTE facilities are limited by the health effects assessment process discussed in Question 36.

SIDEBAR 39

OFFSETS

Offsets are actual emission reductions which are used to mitigate cumulative increases of emissions. Emission offsets are actual emission reductions at nearby industries not necessarily owned by the applicant that must be obtained before a permit to operate is issued to a proposed facility. Additional offsets are required at rates greater than 1 to 1 to assure a net air quality benefit in the area of a proposed project.

An actual emission reduction is one that exceeds the emission reductions required by federal, state, or local regulations. The emission reduction must be quantifiable, enforceable, and permanent. All actual emission reductions are enforced by conditions outlined in the permit to operate the equipment. If emission reductions are obtained from a plant closure, the local air district must receive a letter certifying the permanence of the closure before issuing a permit to operate.

40. 

What is ash and what are some of the concerns about ash from a WTE facility?

Ash is the solid material resulting from the combustion process. There are two types of ash: bottom ash and fly ash. Bottom ash is the unburned and unburnable material remaining on the combustion grates or in the furnace after refuse is combusted. Fly ash is a much finer material with higher concentrations of heavy metals that are recovered from flue gases going though the air pollution control equipment.

The quantity of ash produced will generally equal about 15 to 30 percent of quantity of incoming waste. From a quantitative standpoint, there is significantly more bottom ash than fly ash by weight.[21] Specific characteristics and quantities of each type of ash can vary considerably between facilities, depending on the type of waste burned, the combustion process, and the type of pollution control equipment used.

Concerns about ash center on how it will affect the environment and public health. What causes this concern are toxic substances that may be found in fly ash, particularly dioxins, furans, and heavy metals (e.g., mercury, lead, and cadmium). Concentrations of heavy metals will often increase with the efficiency of the air pollution control equipment.

However, the fact that ash may contains toxic properties does not necessarily mean that it is a danger to public health or the environment. The real issue is the risk of it coming into contact with the environment or the public at concentrations that create problems. These risks can be

minimized by taking proper precautions. To reduce the potential for leaching of toxics in the landfill and contamination of surface and groundwater, ash can be disposed of in a separate landfill cell (monofill) with a special impermeable liner and leachate treatment system. To reduce exposure to fugitive air emissions while handling, transporting, and disposing of ash, the ash can be covered while it is being transported to the landfill and proper ash handling gear can be worn. All ash landfilling techniques require the approval of the Regional Water Quality Control Board and the California Integrated Waste Management Board.

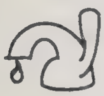
41. What is the proper way to handle and dispose of incinerator ash?

Ash generated at a WTE facility is collected and stored before it is landfilled. In most ash management systems, bottom ash and fly ash are combined, if state law allows, although the characteristics of each are often very different. Fly ash, for example, tends to have significantly higher concentrations of heavy metals than bottom ash.

California law requires that ash be tested to determine whether it is hazardous. WTE ash tends to have levels of lead and cadmium that may classify the ash as a hazardous waste. If determined to be a hazardous waste, ash must be disposed of in a hazardous waste landfill or it must be treated to nonhazardous levels and then disposed of in a traditional MSW landfill or reclassified as a "special waste." Some special wastes are relatively low risk, and may be disposed of at a nonhazardous waste landfill with proper precautions and the permission of the Regional Water Quality Control Board and the State Department of Health Services. Since May 1990, state law requires that some special waste and hazardous waste be treated prior to landfill disposal. Future legislation may also require that ash be disposed of in a separate monofill (a landfill or landfill cell solely for ash) with a single liner, and that MSW landfills accepting ash have a double liner.

A comprehensive ash management plan is essential for every WTE facility. Such a plan should include: methods for preventing fugitive ash emissions; methods for properly transporting ash; methods for controlling leachate; and methods for testing and disposing of ash.

Water Use/Waste Water Disposition

42.  **How much water does a WTE facility use?**

Water consumption by WTE facilities is similar to that of other thermal power plants. The amount of water consumed varies greatly depending on the size of the power plant and the type of cooling system employed to condense the process steam after it leaves the turbine. Most thermal

power plants use wet cooling towers, which reject waste heat via simple evaporation of fresh water in a forced-draft or a natural-draft tower. Air-cooled condensers have been proposed for some WTE applications, which would consume less water and result in fewer environmental impacts, but could result in a reduction in the power output. In addition, facilities that produce only steam, or that utilize excess steam in the electrical generation process, require significantly less water than the above alternatives because the condensing process is eliminated.

43. Does a WTE facility generate waste water or contaminated run-off?

There are three potential sources of water pollutants from WTE facilities. These sources are storm run-off, wash water from facility maintenance, and process waste water.

Rain that falls on roofs and paved areas at the facility site would collect pollutants from these surfaces as it runs off as storm water. This storm water would be similar to that found at other typical commercial and industrial sites. In most WTE facility designs, municipal solid wastes, ash, and other residues are stored inside buildings to keep them dry and would therefore not come in contact with rainfall.

Wash water from facility maintenance would occur as a result of cleaning the machinery and plant areas to remove dust and refuse. The water from wash-down would be channeled and typically directed to a waste water retention basin. This water would be tested to determine if it exceeds the requirements of the National Pollutant Discharge Elimination System (NPDES) permit for the local sewer system. If the waste water exceeds any requirements, it would be treated before discharge.

The third potential source of water pollutants is used process wastewater, two primary sources are the boiler system and cooling water system. The boiler water is heated to steam, used to turn turbines, and then condensed back to water to begin the process again. The cooling water system is used to condense the steam in the boiler system that exits the turbine process. Both are usually closed systems that recycle water, but they are partially drained periodically to remove accumulated residues. This spent process water, or "blow-down" water, is typically directed to a waste water retention pond to be evaporated or discharged to the local sewer system. Another source of used process water is waste water from the ash quenching process. This waste water must be pretreated before it is disposed of in the local sewer system to reduce contaminant concentrations to levels that can be accommodated by the sewage treatment plant. Contaminants not discharged to the sewer must be tested and may have to be sent to a licensed hazardous waste disposal facility.

Noise/Odor

44.  **Are WTE facilities noisy?**

Most of the noise sources at WTE facilities are within enclosed structures, so the noise level from that equipment is considerably lower outside of the structure. Some of the noise sources such as cooling towers or truck-related noise are not within enclosed structures. However, since noise levels from point sources decrease with distance, even these noise levels become much lower by the time they travel to a "receptor" (someone who is close enough to hear the noise). Noise levels from WTE facilities can be further reduced by constructing noise barriers (e.g., walls, fences).

Noise sources at WTE facilities can include the waste processing equipment (e.g., conveyors, magnetic separators, rotary screen trommels, and shredders); the power generating equipment (e.g., turbines/generators, boilers, steam piping, and valves); and cooling system equipment (e.g., air-cooled condenser fans, forced and induced draft fans, circulating pumps, and cooling towers). Another noise source at WTE facilities is from the trucks delivering the waste to the facilities.

45. 

Do WTE facilities smell?

Wherever municipal solid waste (MSW) is being handled, the potential for odor exists. Odor control points at a WTE facility include precombustion operations (MSW fuel processing and storage) and postcombustion controls (stack gas treatment).

At refuse-derived fuel facilities, precombustion operations include the processing of MSW by sorting, separating, and shredding. Once MSW has been processed into RDF, the potential for odors from this fuel is greatly reduced. Furthermore, prior to combustion of MSW fuel, odor from the storage of MSW results primarily from the decomposition of organic materials. Moisture and sunlight can accelerate this process. Thus, at WTE facilities, waste is handled dry and is stored indoors. Also, WTE furnaces are typically designed to draw combustion air from inside the building that houses the stored MSW, which creates a "negative pressure" inside the building relative to the outdoors. This helps to keep MSW odors indoors.

Once MSW is combusted, air pollution control laws require the application of the BACT to control postcombustion stack gas emissions at levels sufficient to protect the public health. This stringent control technology requirement usually provides an adequate degree of control for potential odorous emissions from the stack.

Proper fuel processing and storage, and regular maintenance of the required air pollution control equipment should mitigate most or all potential odors from a WTE facility. However, should a community odor problem arise, most local air pollution control districts enforce nuisance odor regulations, which would require the correction of an odor problem if there are a sufficient number of community odor complaints.

Other Impacts

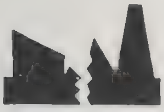
46. Are earthquakes likely to damage WTE facilities?

Earthquake-induced hazards that might affect a WTE facility include surface rupture, strong ground motion, liquefaction, rockfall, landslides, debris flows, seiches, and tsunamis. These potential hazards can be eliminated or minimized by careful facility siting and seismic design.

In facility siting, an important first step is to locate active and potentially active faults to avoid locating a WTE plant over a known fault trace. This will minimize the possibility of a surface rupture damaging the plant during fault movement. In addition, damage resulting from strong ground motion during an earthquake is in part dependent on the type of soil the seismic waves travel through. Hazards from liquefaction [a phenomenon which occurs when essentially unconsolidated, coarse soils (such as manmade fill) are shaken to the point that they lose strength and behave as a liquid] can be avoided by siting the facility away from potentially liquefiable soils. Locating the facility away from steep terrain or areas of known instability is usually a satisfactory safety measure against rockfalls, landslides, and debris flows induced by seismic shaking. Finally, after an earthquake, a facility located near a body of water is susceptible to flooding and structural damage by either a seiche or tsunami. A seiche is generally caused by a catastrophic landslide that enters a body of water and displaces water onto adjacent land. A tsunami, or tidal wave, is caused by displacement of the ocean floor during surface fault rupture. It can be damaging when the resulting tidal wave encounters land. These hazards can be avoided by locating facilities away from coastal areas and low-lying areas adjacent to mountain-bounded lakes.

Along with the precautionary siting steps suggested above, geotechnical and structural design features can be implemented to minimize the effects of nearby seismic events. Geotechnical measures can include foundation design to modify the existing topography, and the removal or

strengthening of susceptible structures and materials. Also, designing a proposed WTE facility to comply with modern seismic safety standards minimize potential structural failures, and may significantly reduce the structural impact from a large earthquake.

47.  **Where will refuse be stored when WTE plant operations are interrupted (due to system failures, accidents, strikes)?**

WTE facilities are typically designed to accommodate two to four days' storage of incoming waste on-site. Longer periods of storage cause numerous problems and waste must be diverted to a landfill. Large facilities typically use a pit to store waste prior to incineration. Smaller facilities will often use a tipping floor for storing incoming waste. Loaders then transfer the waste into the feed hoppers. Storage of waste on-site should not present any major operational problems if the practice is properly controlled. Poor maintenance and housekeeping practices could, however, lead to the generation of unacceptable odors and the potential for rodent infestation.

In the event of an extended shutdown period, contingencies must be developed for managing the MSW going to the WTE plant. Depending on the length of the shutdown, collection vehicles will often either be diverted directly to a landfill or transfer station. Contingency plans are typically developed as part of the permitting approval process and should take into account community needs and concerns.

48. How might a WTE facility affect the property values in the immediate area?

A WTE facility's effect on property values from would depend on several factors. These factors include a facility's compatibility with surrounding land uses, and its actual or perceived environmental impacts.

Building any industrial facility in a nonindustrial area could adversely affect property values. Zoning designations in the area would determine the impact of the industrial facility. For example, locating an industrial facility, in proximity of a residential neighborhood could affect the property values.

Locating a WTE facility within an existing or proposed industrial area could minimize these effects. Residential areas located next to industrial zones are more likely to retain their value, which has already been adjusted for proximity to the industrial area. Therefore, the impact to

residential property values is likely to be less if the facility was located in an area previously zoned industrial.

The design of a WTE facility could also affect property values. If a facility is properly designed to avoid or minimize environmental impacts, including visual impacts, it should have a minimal effect on nearby property values. This is especially true if it replaces undesirable land uses (i.e., the site contains existing facilities or uses that are unattractive or are causing environmental impacts) and is compatible with the surrounding area. A facility that is attractively designed and properly operated could be expected to minimize the effect on nearby property values.

49. Are WTE facilities safe to operate?

While fires are possible with all WTE facilities, explosions occur primarily in RDF facilities that process waste before combustion.

Since RDF facilities first appeared in the United States in the early '70s, many explosions have occurred, causing considerable damage to equipment and property and sometimes injury to personnel. Most explosions happen when high-speed shredders come in contact with potentially explosive MSW (e.g., gas canisters) increasing the potential for explosions. Explosions have also been reported in auxiliary processing equipment, such as dust suppression devices (baghouses) and dryers. Causes of explosions are now better understood, as are ways to minimize their occurrence, damage to equipment, and risk of injury.

There are a number of preventive measures that can be taken by WTE facility operators to reduce the risk of explosions, including: educating the public about proper disposal of explosive materials; installing a metal and chemical explosion detection/suppression system; inspecting MSW; providing operator safety training and restricting personnel from high-risk areas during equipment operation; using dust and fume hoods liberally to vent volatile gases; and housing the shredder in an isolated concrete room to protect personnel and equipment.

50. How much will WTE facilities cost to construct and operate?

The cost of WTE is made up of four basic components:

- Construction cost
- Operation and maintenance cost
- Revenues from sale of recovered materials and energy
- Fees paid by users for the disposal of their refuse

Construction costs: The cost to build a WTE facility can range from $20 million for a small plant to over $500 million for a large one. A rule of thumb is $100,000 of construction cost for each ton of solid waste that will be processed daily. Thus, a rough estimate for a plant designed to receive 1,000 tons each day is $100 million (1,000 tons per day x $100,000 per daily ton). The most significant cost factors are the size of the plant and the type of pollution control equipment needed to meet environmental regulations. Typically, a 3,000-ton-per-day WTE facility will require $15 million to $20 million of air pollution control equipment. Other important factors include characteristics of the facility site, the amount of redundancy (or back-up) in the plant, and contractual requirements (such as performance guarantees and liquidated damages). These costs, as well as pollution control costs, are usually financed over a 20-year period. The annual cost of financing a WTE facility is typically called "debt service."

Operating and maintenance costs: Costs to operate and maintain a WTE plant include labor, utilities, disposal of plant ash and other residues, insurance, and replacement parts. These costs typically range from $5 million to $10 million per year for a 1,000 TDP facility. A significant factor is the cost of residue disposal from the plant, including ash produced by combusting the refuse, wastes such as refrigerators and stumps that cannot be buried, and wastes that must be landfilled when the plant is undergoing repairs or maintenance. Ash disposal costs will vary based on ash toxicity, environmental regulations, and the availability and location of landfills. Ash disposal costs average $20 per ton if it can be disposed of in a regular MSW landfill, to $100 per ton or more if it must be disposed of in a hazardous waste landfill.

Revenues from sale of energy and materials: The cost of building and operating a WTE plant is offset to a large extent by income received from the sale of energy produced and materials recovered. The major factors affecting the amount of income are: the price paid for the electricity or other energy produced; the amount of waste processed; and the market value of the recovered materials. Revenues may range from $3 million to $12 million per year on a 1,000 TPD facility.

Disposal fees: Any shortfall in revenues needed to cover construction cost financing and operations and maintenance costs must be paid by those who use the facility to dispose of their wastes. This is often called the "tipping fee." It may be paid directly by the users as a monthly charge on the garbage bill, or may be paid by the local government and recovered from the users through taxes or service fees.

Typical cost ranges are as follows:

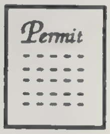
	Per Ton	Per Household (Monthly)
Debt Service	$30-$40	$7.00-$10.00
+ Operating & Maintenance	$25-$50	$6.25-$12.50
- Revenues	($40-$20)	($10.00-$ 5.00)
Tipping Fee	$15-$70	$3.75-$17.50

51. What are some of the economic risks of WTE? Who should assume responsibility for those risks — the WTE vendor or the community?

There are a variety of economic risks in the development, construction. and operation of a WTE plant. Each risk must be allocated to a party. Risk allocation should be negotiated thoroughly between the parties in the project. While there is no set formula as to which risks should be borne by the community and which by the vendor, typically the risks are allocated as follows:(22)

Risk	Vendor	Community
Supply of the waste		X
Construction and operating cost	X	
Performance of the system	X	
Availability of landfill for process residues		X
Markets for recovered materials and energy	shared	shared
Changes in law and environmental requirements		X
Uncontrollable events	shared	shared

Permitting Requirements/Siting

52. 

What regulatory requirements apply to proposed WTE facilities?

Federal, state, and local agencies all play roles in controlling and monitoring the activities and environmental effects associated with a WTE plant. Air emissions, solid waste handling, sale of power, ash handling and disposal, and land-use conflicts are subject to review and approval by these regulatory agencies (see Figure 52-1). Once a site is selected for a WTE plant, the lead agency responsible for California Environmental Quality Act (CEQA) compliance begins the environmental impact review process. The planning department within that local agency typically takes the lead.

The first step under CEQA is the preparation of the initial study identifying construction and operation impacts. The lead agency determines if these impacts are potentially significant. If so, the 12-month environmental impact report (EIR) process begins. Since 1986, all WTE plants have been required to submit a full EIR. The draft EIR (DEIR) is reviewed by the public and other agencies and revised based on the comments received. If the DEIR is certified by the lead agency, it is then filed with the state as the Final EIR.

A WTE project must obtain four key permits including: a solid waste facilities permit, an air permit, a waste water discharge requirements permit, and a local land use permit. In addition, whether the ash is hazardous and where it may be disposed of must be determined. Table 52-1 summarizes these and other permits that may be required. To obtain a solid waste facilities permit, a WTE facility must be consistent with the countywide integrated waste management plan, which specifies types and general locations of future solid waste facilities. If a proposed WTE facility is not designated in its countywide integrated waste management plan, the county must amend its plan before the facility can be approved by the local enforcement agency (LEA) or the CIWMB. In addition to a determination of CIWMB conformance, the LEA must issue a solid waste facilities permit.

A proposed plant must receive two permits from the Bay Area Air Quality Management District (BAAQMD): the authority to construct (AC) before plant construction can begin, and the permit to operate, issued during early plant operation. All plants now need a health risk assessment that evaluates health effects of toxic pollutants. The California Air Resources Board (ARB) provides technical assistance to local air districts upon request and reviews emissions estimates and modeling during the health risk assessment process. The Department of Health Services reviews the health effects and determines the project risk. The local districts

determine the acceptability of the risk. The Environmental Protection Agency (EPA), as the federal agency responsible for the Clean Air Act, delegates the authority of issuing air permits to states and local air quality agencies. EPA also oversees the permitting process and comments as necessary.

A proposed facility that produces more than 50 megawatts of electricity falls under the jurisdiction of the California Energy Commission (CEC). The applicant submits an application to the CEC for review. The CEC reviews environmental impacts, reliability, and safety and determines the need for power. CEC approval can be obtained in lieu of local and state permits. The CEC works closely with local and state agencies to ensure that all local and state agency permit requirements are included in the CEC's conditions for approval. Any federal permits, and federal permits whose issuance is specifically delegated to local agencies, must be obtained in addition to CEC approval.

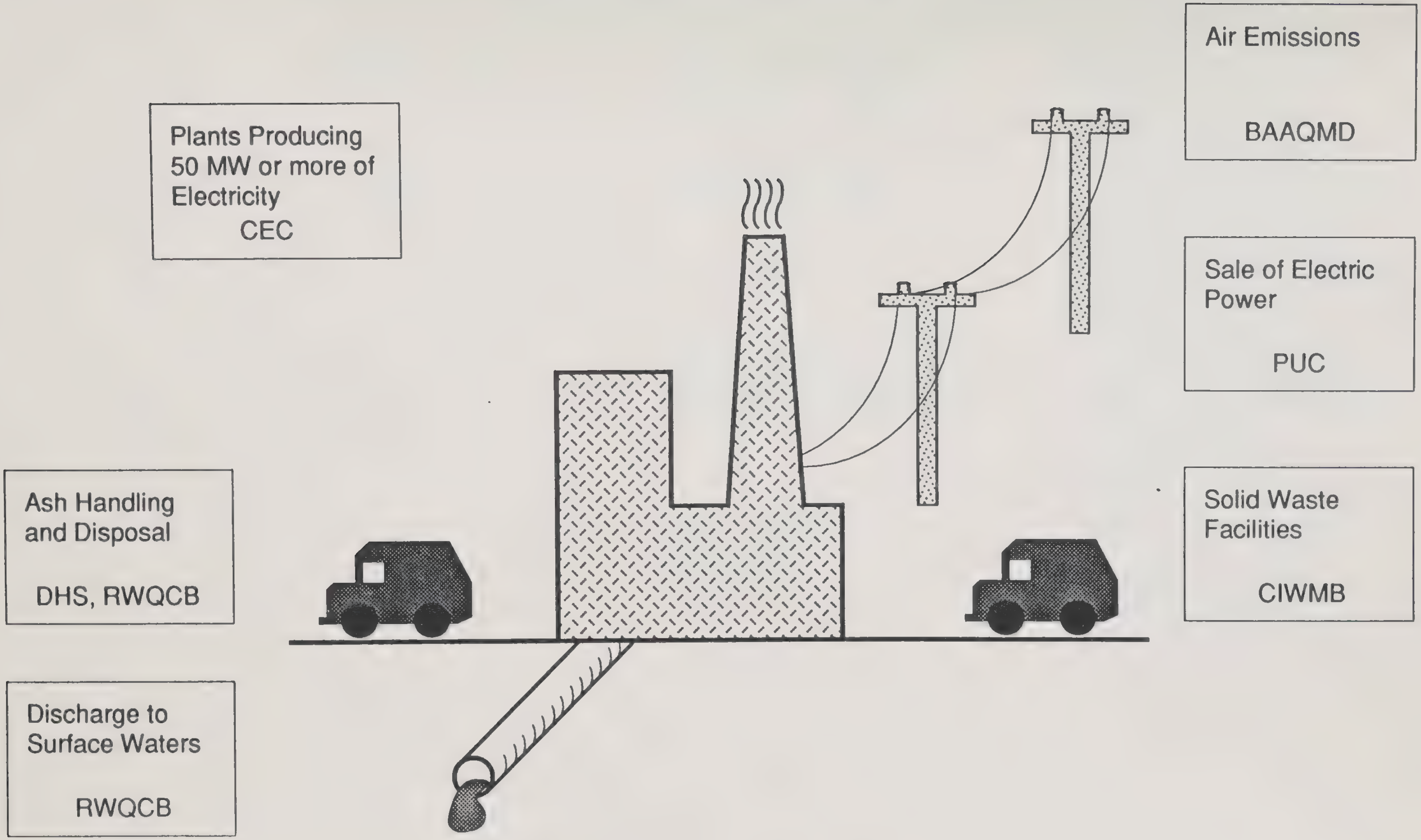
The State Water Resources Control Board (SWRCB) and the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) issue waste water discharge permits for the plant's effluent and also determine the acceptability of the landfill for the ash, if it is not a hazardous waste.

If the proposed plant is located in a coastal zone or is adjacent to the San Francisco Bay shoreline, it may need permits that show consistency with bayshore or coastal plans.

In the past 10 years, the permit processes for WTE plants in California have proven to be major stumbling blocks. About 11 proposed WTE facilities have entered the regulatory review over the last 10 years and of those, three were permitted to operate. Table 52-2 summarizes the status of these plants.

Figure 52-1

WTE Activities Regulated by State and Regional Agencies



Source: Brown, Vence & Associates

Primer-WTE

Table 52.1
PERMITS REQUIRED FOR WASTE-TO-ENERGY FACILITIES

Regulated Activity	Type of Permit/ Regulatory Requirement	Responsible Agency	General Requirement
• Land use	• Use permit	• Local agency	• Local planning department must determine compatibility with local zoning, general plan, and community objectives.
	• Building and grading permits	• Local agency	• Local building department inspects to ensure it meets applicable building codes and grading standards.
• Solid waste	• Solid waste	• Local Enforcement Agency facilities permit or California Integrated Waste Management Board	• LEA or CIWMB determines if the project is consistent with the county solid waste management plan and amends plan if not. Project standards for solid waste handling and disposal and must not have a major effect on public health and safety.
• Ash disposal	• Ash disposal	• Regional Water Quality Control Board (RWQCB)	• The RWQCB determines what type of landfill it must be disposed in.
• Ash disposal	• Ash disposal	• Dept. of Health Services	• DHS determines if the ash is hazardous.

Table 52.1
PERMITS REQUIRED FOR WASTE-TO-ENERGY FACILITIES (continued)

Regulated Activity	Type of Permit/ Regulatory Requirement	Responsible Agency	General Requirement
• Air	• Authority to Construct	• Bay Area Air Quality Management District	• BAAQMD reviews project equipment to ensure it meets emission limits, and ambient air quality standards. New Source Review rules regulate emissions exceeding limits for specified pollutants. The facility may also require best available control technology (BACT) and emission offsets.
	• Permit to Operate		• BAAQMD reviews operational plant for compliance with conditions of Authority to Construct. District conduct test of emissions.
• Waste water	• Waste water discharge permit	• State Waste Resources Control Board Regional Water Quality Control Board	• If there is discharge to surface water, the RWQCB determines that the waste water meets clean water standards.

Table 52.1
PERMITS REQUIRED FOR WASTE-TO-ENERGY FACILITIES (concluded)

Regulated Activity	Type of Permit/ Regulatory Requirement	Responsible Agency	General Requirement
•Power plants 50 MW or more	• Certification of power plant and satisfaction of CEQA requirements	• California Energy Commission	• CEC must determine the need for the facility, acceptability of technology, site acceptability protection of public health and safety.
•Coastal zone	• Coastal development permit	• California Coastal Commission	• CCC must assess project for consistency with appropriate use of coastal zone.
•Bayshore	• Development permit	• San Francisco Bay Conservation and Development Commission	• BCDC reviews project for consistency with appropriate uses of Bay shoreline.

Table 52-2

Status of WTE Projects in California

Name of Facility	Location	Status
Commerce	City of Commerce	Operating as of 1987.
Stanislaus	Crows Landing	Operating as of 1989.
Lassen College	City of Susanville	Permits obtained; operated 8 months; closed due to technical and permit problems in 1985.
Tri-Cities	City of Fremont	Voted down by residents of three participating cities in 1986.
West Contra Costa County	City of Richmond	Inactive.
Lancer	City of Los Angeles	Mayor withdrew support for project in 1987.
Sander	City of San Diego	Referendum ended project in 1987.
SERRF	City of Long Beach	Operating as of 1989.
San Francisco	City of Brisbane	Voted down by City of Brisbane in 1982.
Bay Area Resource Recovery Facility	Redwood City	Lost waste supply in San Francisco. Vendor withdrew CEC application in 1988.
North County Resource Recovery Association	City of San Marcos	In negotiations as of 1990.
Irwindale	City of Irwindale	CEC dismissed project for failure to obtain air emissions offsets.

53.  **How can the public participate in the environmental review and permitting process?**

Although the environmental review and permit process for a WTE plant may seem complex to the layperson, the public has many opportunities to participate. Regulatory boards and commissions typically receive written comments and hear testimony at public meetings and hearings. Public meetings are held at the discretion of the decision-making body. However, they must be held, and should include a formal written record of comments received (they are required by law for some agencies). The local planning commission, the CIWMB, RWQCB and the California Energy Commission (CEC) each hold public meetings and hearings to receive comments on relevant aspects of a WTE plant. These hearings are normally held after the staff reviews the project and before the regulatory agency makes its final decision. A public comment period is designated to receive written input. The BAAQMD, for example, holds no public hearing, but posts a public notice of the Air Pollution Control Officers' (APCO) preliminary decision and receives public comments for 30 days thereafter.

Should a regulatory agency's decision on a WTE plant be appealed to a higher authority (e.g., an appeal of a regional water quality control board decision to the State Water Resources Control Board), an additional hearing process will be initiated to receive comments on the decision.

Under the CEQA process, the lead agency may hold a project scoping meeting before the draft environmental impact report (DEIR) is prepared. These scoping meetings, while not required, are particularly helpful for complex projects such as WTE plants, and provide a public forum for raising concerns at the earliest possible time in the environmental review. The lead agency may also hold a hearing on the DEIR.

The CEC is the lead agency for plants over 50 MW. As such, it holds numerous public workshops before the staff analysis is prepared and a series of public hearings on the staff analysis and the commission's prepared decision. In addition, the CEC has an independent public advisor who can inform the public on how it can participate in the proceedings.

The permitting process is complex and there are several means and schedules for public input. An interested citizen would do best to contact the key responsible agencies and ask to be added to their mailing list for notification of meetings, hearings, and comment deadlines.

54.  **How will regulatory agencies monitor compliance with all permit conditions?**

After the WTE plant is operating, regulatory agencies keep a watchful eye for violations of permitted operating conditions.

The BAAQMD monitors air pollution permit conditions, including: criteria and toxic pollutant emissions (daily and annual basis); equipment breakdown; ventilation in the tipping area (to minimize odors); incinerator temperature; waste throughput (hourly, daily, and annually); stock conditions; air pollution equipment performance; supplemental fuel; continuous emission monitors; source tests; and adequate record-keeping. Compliance with these conditions is verified by on-site inspections and by submitting reports to the BAAQMD. A violation notice is issued for each condition violation.

While the Local Enforcement Agencies (LEAs) are responsible for actually issuing permits for WTE plants, compliance with the permit conditions is monitored through on-site inspections conducted by CIWMB personnel. A violation notice is issued for each condition violation. Inspectors look at the length of time the waste is in the pit, the traffic patterns on the tipping floor, nuisances (dust or odor), and the amount of tonnage the plant receives daily.

For plants over 50 MW, the CEC monitors for compliance with conditions of approval by requiring the plant operator to submit quarterly compliance reports. These reports contain data and information relevant to all aspects of plant operation. The CEC staff reviews these reports, conducts on-site inspections as necessary to verify compliance, and attends source tests.

In all cases, if a violation notice is issued, the operation of the plant is carefully monitored and, if necessary, restricted until the plant is no longer out of compliance. If necessary, further enforcement action will be taken against the plant to correct the problem that is causing the violation.

55.  **How are appropriate WTE sites identified and evaluated?**

An appropriate site for a WTE facility must satisfy a community's goals and objectives and must meet requirements for environmental quality and technical feasibility. These requirements are typically expressed as siting criteria, and are used to exclude unsuitable locations.

In communities where the project developer has not proposed a specific site, the site selection process typically follows these steps:

Establish siting requirements:

- Community objectives — What local policies on land use, aesthetics, traffic, and waste management would affect the site selection?

- Environmental quality — What environmental standards must the site meet to minimize impacts to air, water, natural and cultural resources, and to protect health and safety?

- Technical feasibility — How much solid waste is available over the life of the project? What activities, such as recycling, materials recovery, and collection of household hazardous waste, will occur at the site? How much storage space is needed for MSW on-site? Is there a potential steam user near the site?

- Solid waste policies — Is the WTE plant being sited at a location that conforms with the approved countywide integrated solid waste management plan?

Establish and apply siting criteria: Based on the siting requirements, criteria are developed that can be applied to maps of the study area. Some criteria will exclude areas from further considerations (e.g., land zoned residential); some criteria will rank sites (e.g., flat sites would be less expensive to develop and therefore preferred over hilly sites). A map is then drawn up showing potential suitable sites for a WTE plant.

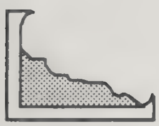
Detailed site evaluation: Experts in biology, geology, hydrology, and archeology will examine each potential site through field work and data collection. Community review will also help identify sites that are unacceptable to the community.

The WTE site selection process needs early, ongoing participation by the affected community. Chances of cooperation in finding a truly appropriate site can be increased if residents feel they are really being heard. The "not in my back yard" (NIMBY) syndrome occurs because residents fear there will be health hazards related to air emissions, ash disposal, impacts of truck traffic, and nuisance effects of litter, odor, and noise. These issues need to be handled honestly and openly throughout the site selection process.

Typical siting criteria for WTE facilities: The following siting criteria are generally accepted as being suitable for waste disposal facilities:

- Areas must be zoned industrial
- Sites must be compatible with surrounding land uses
- The site should be of sufficient size
- The site must have access to utility services and to major roadways
- Proximity to power purchaser must be ensured
- Land use compatibility/visual impacts must be checked
- Site should be outside 100 year flood plain
- There should be adequate depth to the groundwater
- Site should be outside active fault zones
- Cultural resources should be avoided
- The soil should be suitable
- There should be sufficient drainage
- The site's slope should be checked
- Biological resources should be avoided

LANDFILLS

56.  **What are current and future landfill disposal constraints in the Bay Area and the State of California?**

Although landfilling is the last resort in an integrated waste management system, there will always be a need for landfills for wastes that cannot be reduced, reused, recycled, or incinerated. There are, however, a number of constraints to landfill disposal in the Bay Area and California.

Dwindling capacity: The quantity of MSW requiring disposal in California is expected to increase from 40 to 45 million tons between now and the year 2000. At the same time, landfill capacity is shrinking rapidly in many parts of the state. A number of California counties could run out of landfill capacity within the next decade unless new facilities are sited. These include the counties of Los Angeles and San Bernardino as well as the Bay Area counties of Contra Costa and San Mateo. Because it is landlocked and has no place to site a new landfill, the City and County of San Francisco has been exporting its MSW to neighboring counties since 1970.

Siting difficulties: The siting of a major new landfill requires five years or more and in many situations is virtually impossible. Strong public opposition to the siting of large regional landfills also known as NIMBY is commonplace throughout the state. In the last nine years, the only landfills that have been sited in populous counties have been Kirby Canyon (Santa Clara County) in 1984 and El Sobrante (Riverside County) in 1985.

Increasing costs: Landfilling costs (tipping fees) in the future are expected to increase dramatically due to the escalating cost of land (especially in coastal communities), more demanding permitting, operations and closure requirements, lengthy siting processes, and increased transportation costs to distant areas.

57. What are some of the potential benefits of landfills?

Good landfill management can be used to turn many potential disadvantages into advantages. Methane gas, generated by microbial decomposition of organic wastes at landfill sites, can cause an explosion or can be a fire hazard. Many landfills, however, harvest this gas and use it on-site for power generation, or sell it as fuel, one version of waste-to-energy. Old landfill sites may be mined in the future for valuable materials, such as metals. Finally, landfill sites can be used for a variety of waste management pursuits. Closed fills are often used as transfer station sites, with the remaining acreage landscaped for parks or other public uses. Closed landfills hosting transfer stations as well as operating landfills are ideal places to establish recycling facilities, composting yards, and collection sites for hazardous wastes generated by households and small businesses. The Palo Alto landfill composts yard wastes to use as final landfill cover, and the San Francisco transfer station, built on a former landfill, has established a household hazardous waste collection facility and a number of recycling programs.

While California and the Bay Area must become less dependent on landfill disposal, through waste reduction, recycling, and other means, landfills will continue to play a vital part in waste management. Even the most sophisticated integrated waste management systems will produce nonrecyclable refuse, ash, or other material that must be landfilled.

58. What are some of the potential environmental impacts of landfill disposal operations?

Municipal landfills contain a variety of waste products, ranging from relatively inert materials (building materials and rubble) to relatively hazardous materials (discarded household chemical products). The degree of environmental impacts resulting from a municipal waste landfill will depend upon many factors, including the actual composition of the waste, the climate and hydrogeology of the site, and the age and management of the landfill. The following discussion illustrates potential environmental impacts typically associated with municipal waste landfills.

MSW can decompose within a landfill, producing solid, liquid, and gaseous by-products. Infiltrating rain water, groundwater and surface water can seep into a landfill, mix with liquid waste, and produce "leachate." Landfills in wet (humid) climates generally have a greater

leachate production potential. Contaminants contained in landfill leachate can pollute underground aquifers and surface waters if adequate precautions are not taken in locating, designing, and constructing the landfills. For municipal waste landfills, the health risk of greatest concern to the public is the risk of water supply contamination. Instances of groundwater contamination have occurred with some existing municipal waste landfills.

As landfill waste decomposes, gases are formed and are emitted to the ambient air above the landfill surface. Landfill gas can also migrate laterally beneath the surface to locations off-site, including into the basements of nearby homes. Landfill gas production can persist for decades after the landfill is closed.

Landfill gas is chiefly composed of methane and carbon dioxide, both of which are colorless and odorless. Methane can explode at certain critical concentrations if it is allowed to accumulate in enclosed areas on or near the landfill. Landfill gas also contains odorous sulfur compounds, which could be detected in the vicinity of a landfill and is a potential community concern. Other gaseous compounds include volatile organic compounds (VOC), which can contribute to the formation of photochemical smog, and quantities of toxic organic compounds, such as vinyl chloride and benzene, both of which are cancer-causing. Recent research has shown that the total amount of carcinogenic substances emitted into the air from a landfill, even under controlled conditions, is significant. In fact, they may exceed those that are emitted from a controlled WTE facility processing an equal amount of municipal waste. Emission estimates from a controlled landfill range from 5.7 to 47 times that of a controlled WTE facility. (25)

In addition to air and water impacts, municipal waste landfills present other potential environmental concerns. A closed landfill may be unfit for other beneficial uses for many years, and in some cases for many decades. Landfill operations create litter, dust, noise, and traffic hazards. Pathogenic bacteria and other biological vectors of diseases (e.g., rodents) have been detected at landfills. Landfills result in a loss of potential renewable energy, compared to other waste management options (e.g., recycling, WTE facilities). Finally, continued reliance on municipal landfills at present rates is straining this important waste management option. A 1988 study by the National Solid Waste Management Association (NSWMA) reported that nearly 14,000 landfills, or 70 percent of total U.S. landfills, have closed since 1978, and almost 30 percent of the 6,500 existing landfills will close by 1993. (26) According to NSWMA, these closings will result in an overall yearly capacity loss of approximately 56 million tons, more than one-third of the landfill capacity nationwide.

Transfer Stations

59. What are transfer stations and what role do they play in solid waste management?

A transfer station is a facility designed to receive waste from the general public and smaller collection vehicles (carrying approximately 2 to 10 tons) and reload the waste into large-capacity vehicles (with approximately 20 to 25 tons). These vehicles then transport the waste to a final disposal site, such as a landfill or waste-to-energy facility. This system is needed when the collection service area is too far from the landfill for direct transport of waste in the collection vehicles to be cost effective. Transfer stations often receive waste from the general public and commercial customers as well, acting as a local disposal site.

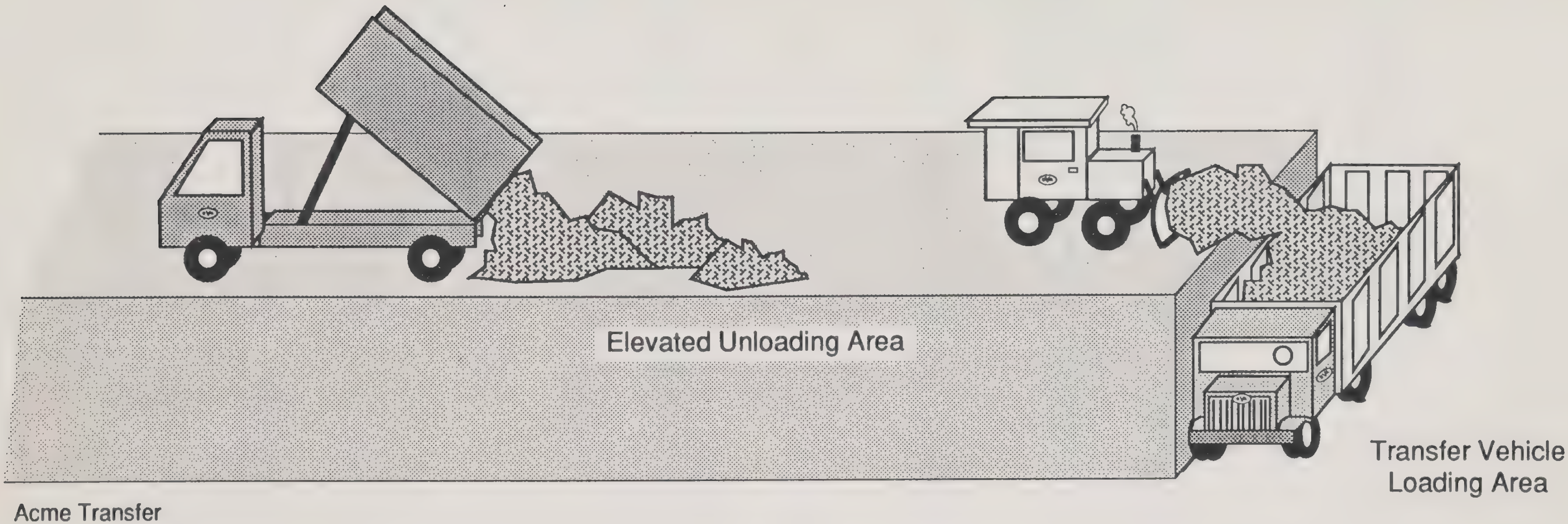
As the number of local landfills continue to diminish in the future and as new landfills are sited further from population areas, the role of transfer stations will become more important for cost-effective waste management. The City and County of San Francisco, for example, does not have a permitted landfill within its boundaries. Therefore, all of its MSW is delivered to a large transfer station and transported 120 miles round trip to a landfill in Alameda County.

In addition to improving the economies of transporting garbage to a landfill, transfer stations can serve as central facilities for a variety of recycling, transporting, and materials recovery activities. For example, public and private vehicles that are rich in a particular recyclable material (e.g., yard wastes, cardboard, concrete) can be diverted to a particular part of a transfer station site so that these materials can be recovered. In addition, at transfer stations, some wastes can be manually or mechanically sorted to remove particular subflows prior to disposal.

In 1989, there were 20 transfer stations in the Bay Area handling the majority of the wastes going to landfill.

Figure 59-1

Transfer Station Loading Area



Source: Brown, Vence & Associates

IV. Selecting, Integrating and Implementing Options

In order to develop a solid waste management system that serves us effectively and efficiently, we must be able to select among the various options available, integrate them into a workable whole, and then implement them. This section presents the integrated solid waste management process as a means of selecting and integrating options, and the major implementation tasks required for realizing a solid waste management system.

PLANNING AND IMPLEMENTATION

60. How does a community develop an integrated waste management plan?

The first step in the integrated waste management planning process is establishing goals; that is, defining what the future solid waste management system should accomplish. Goals provide the overall framework on which the plan is built. They should also mesh local needs and concerns with the State's AB 939 planning requirements. These goals might be to:

- Reduce waste generation;
- Minimize waste going to landfills;
- Minimize user cost;
- Recover materials for reuse or recycling;
- Minimize environmental impacts and maximize public health; and
- Recover materials to convert to energy.

The second step is evaluating how effectively the existing solid waste management system accomplishes the established goals. As part of a local government's first AB 939 source reduction and recycling element, it is extremely important that accurate "baseline data" be developed against which future progress can be compared. Specifically, local governments must review and evaluate a variety of factors about its current solid waste management system. (See Sidebar 60.) By thoroughly

examining these factors, the constraints and limitations of the existing system and the requirements of the future system can be highlighted.

The third step is identifying the appropriate range of technologies and programs that might help achieve the established waste management goals. These options can include technologies or programs in source reduction, recycling, materials recovery facilities, composting, waste-to-energy, and landfilling. Options can either be defined as specific technologies within a subgroup (e.g., mass-burn versus RDF technology) or among subgroups (e.g., composting versus recycling).

The fourth step is evaluating options. In order to make meaningful selections among the range of options, criteria must be developed to compare and evaluate them. The evaluation criteria should refine the established goals into discrete and quantifiable units and reflect a community's solid waste management preferences and concerns. For example, if one established goal is to minimize environmental impacts, then one associated criterion might be the extent to which the technology or option complies with local or state environmental guidelines. Another environmental criterion might be the extent to which health risks to the community are minimized. Once a set of criteria is developed, each option or system is evaluated against each criterion. Then each option is numerically scored based on its degree of compliance to the criterion. From this, a single numerical score is calculated for each option. The preferred components of the future system can then be determined by ranking the options from highest (most preferred) to lowest value (least preferred). The option with the highest value (that is, those that maximize compliance with the community's solid waste criteria) is taken to be the optimal system for the community.

The final step of the planning process is developing an implementation strategy. The implementation strategy defines specific tasks required to realize the optimal system, the entities responsible for each task, the timeline for implementation, and budgetary milestones. AB 939 has tightened past requirements regarding the specificity of implementation strategies, schedules and the sources of funding.

SIDEBAR 60

EVALUATING THE EXISTING SOLID WASTE MANAGEMENT SYSTEM

The following factors should be considered when evaluating existing solid waste management system:

- The quantity and composition of wastes generated.
- The projections of future quantities and composition.
- The existing refuse storage system, including:
  - — methods, and
  - — efficiency.
- The existing refuse collection, transportation, and processing system, including:
  - — quantity,
  - — methods,
  - — efficiency/effectiveness,
  - — extent and cost of service, and
  - — responsibility and terms of service.
- The existing waste reduction, recycling, and waste-to-energy programs and facilities, including:
  - — quantity,
  - — methods,
  - — efficiency/effectiveness,
  - — extent and cost of service, and
  - — responsibility and terms of service.
- The existing disposal system
  - — landfill capacity available (tons, years); and
  - — current and future costs.

61. Who are the key players on a waste management team? What are their roles in planning, implementing, and operating a solid waste system?

In order to provide a balanced waste management system that both reflects community attitudes and concerns, and is technologically workable, the key players on the waste management team must draw from government, private sector, and local citizen representatives. Specifically, key players include:

Local solid waste management officials: Local waste management officials act as interpreters of state, county, or other regulations at the local level. They are ultimately responsible for managing solid waste in an environmentally safe and cost effective manner. They are also responsible for developing community waste management goals. Whether planning or operating the waste management system, it is their duty to

ensure that activities reflect the state's requirements, as well as the local community's goals, concerns, and priorities regarding solid waste issues.

Waste collector: The waste collector, whether public or private, is the prime mover of solid waste through the system. Closely involved in the day-to-day operations of the solid waste management system, collectors have special knowledge regarding the needs and constraints of the existing system and what may and may not work in the future system. Accessing this knowledge is important to designing a technically workable future system.

State regulatory officials: State regulatory agencies establish operating guidelines and policies (by establishing a waste management hierarchy, solid waste legislation, etc.) upon which the solid waste system is built. Regulatory agencies also review system development and performance to ensure that they are in compliance with environmental standards.

System vendors: The vendors supply the specific technological systems that will be used to manage the solid waste. Depending on the way the vendors are procured, they may also be the system operators.

Local citizens: The local citizenry ultimately uses and pays for the solid waste management system. Citizen involvement in the planning and decision-making process is critical to guarantee that the selected options will be employed and supported to their fullest capacity. As daily users of the system, they can also provide immediate feedback to the local officials regarding the extent and quality of service being provided.

Interest groups: Interest groups organize to represent the concerns or objectives of a select portion of the community, and ensure that these concerns are addressed in the planning process. They may also serve a monitoring role in the operation of the waste management system.

Consultants: Consultants act as experts providing input and analysis on technical, economic, and environmental characteristics of waste management systems. In this capacity, the consultant often brings together all players and synthesizes their input, and develops a plan of action.

62. What are some of the methods for including the general public in the decision-making process, as well as methods for addressing community concerns?

Building a WTE plant, siting a landfill, or designing a curbside recycling program may raise concerns about increased garbage rates, health risks, and conflicts with community quality of life goals. These perceptions, whether real or imagined, may cause citizens to resist new waste management programs and facilities.

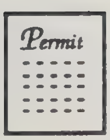
Early and ongoing public participation in local waste management planning and facility siting can help gain public cooperation. The goal is to help interested citizens be active partners in waste management decision-making. Members of the public should be offered plenty of opportunities to express their views through:

- Public workshops and focus groups
- Citizens' advisory committees with access to the decision-makers
- Public hearings as part of permit process
- A hotline for information and input

All these methods will become more powerful if well-publicized through local media, through flyers, and using other means.

There is no guarantee that the public will accept all aspects of a proposed waste management project. However, the likelihood of gaining community cooperation will be increased by following these seven basic rules:

- Show a commitment to using the waste management hierarchy in implementing new programs and facilities.
- Accept and involve the public as a legitimate partner.
- Carefully plan the communication of issues and select skilled communicators who speak clearly and with compassion, avoiding technical jargon and distant, unfeeling abstractions.
- Listen to the members of the public and avoid making assumptions about their views.
- Be honest and frank to build trust and credibility.
- Coordinate and collaborate with other credible organizations.
- Meet the needs of the media to ensure accurate reporting of issues.



63. What are some of the major tasks involved in implementing various options? How long does it take to implement these options?

Once a community chooses a solid waste management option (or system of options), the next step is plan implementation. The basic tasks of implementation are more or less the same for any management option, but the time involved can vary significantly. Following are the general tasks required to implement an option, along with the time required to complete it:

Program design: If a facility has to be developed, this activity may involve building, equipment, and/or operations engineering. For curbside

recyclables or yard waste collection, this may include route design and processing center engineering. Depending on size and complexity of the operation, design may take one month (e.g., a simple yard waste composting project) to a year or more (e.g., waste-to-energy or landfill facility).

Site selection: If a facility is needed, an operations site will be necessary. Tasks under site selection may include: development of selection criteria, potential site identification, and application of criteria to the alternatives. The time involved depends greatly on the extent of state and local regulation regarding facility siting and degree of community opposition. A small materials processing site may take as little as one month, whereas landfill siting could take three to five years.

Securing markets: Recycling, composting, and waste-to-energy options often entail selling recovered products (materials and/or energy) to offset operational expenses. Securing strong, reliable markets (secondary materials markets, brokers, end-users, utilities, or others) is thus a key task. It may take several months or even become an ongoing activity, depending on the nature of the market. Securing energy markets is generally a more complex and time-consuming process than securing materials markets.

Securing disposal capacity: This is particularly important to options such as waste-to-energy that produce a by-product requiring some type of final disposal, such as ash. Ash requires landfilling, and without reliable, long-term capacity commitments from landfills, facility operation is jeopardized. Depending in part on the number and capacity of nearby disposal facilities, this could take several months or much longer.

Vendor procurement: If an option requires equipment, vehicles, and/or operators, a vendor will be required to supply these. The basic steps to procuring a vendor are as follows:

Issue a request for qualifications — This document essentially asks potential vendors to supply their qualifications and capabilities to perform/supply the specified goods and/or services required.

Evaluation and short list — Vendor responses are evaluated against the established minimum vendor qualifications. Those meeting minimum qualifications are then short-listed, meaning they will be included in the next round of the selection process.

Issue bid documents — Short-listed vendors are invited to submit price proposals and conditions for the required goods and/or services.

Evaluation and selection — Proposals are evaluated against the required goods or services, and often that vendor willing to provide the commodity at the least cost is selected.

Negotiation and contracting — Once the preferred vendor is selected, final negotiations regarding price, terms, and conditions of service are performed. If an agreement is reached, a contract is entered into.

The time required for vendor procurement will depend to a great extent on the complexity and cost of goods or services required. It also depends on the nature of existing procurement laws and on the procurement path selected. Procurement of a vendor to supply vehicles for a curbside recycling program may take several months, whereas procurement of a full-service vendor for development and operation of a waste-to-energy facility may take one to several years.

Permitting: Most solid waste management operations, and particularly materials recovery or processing operations, composting facilities, waste-to-energy, or landfilling options will require local and/or state environmental permits before the activity can be undertaken. Depending on state and local regulations, permitting a yard waste composting facility may only take several weeks, if permits are required at all. Fully permitting a waste-to-energy or landfill facility can consume a year or more.

Waste flow agreements: Some solid waste management options, particularly materials recovery, waste-to-energy, and landfill options, require a minimum intake of waste to ensure their economic viability. In such cases, waste flow agreements are often required to assure adequate flow of wastes to the facility. Communities agree, in part or whole, to direct wastes generated within their borders to the planned facility. A municipal ordinance is a common means of implementing flow control. The time required for development and ratification of an ordinance may be several months or it may be considerably longer.

Financing: If significant capital costs are involved, arrangements for construction and take-out financing may be required. Depending on the type of operation and its economics, arrangements may take several months or more.

Construction: For those options requiring any type of new or renovated facility, construction will be required. For a simple materials processing center, construction may take up to several months. A large waste-to-energy facility might take two to three years.

Start-up and performance testing: Operations that perform waste processing of some type will need a start-up and performance testing (or shake-down) phase. This is done to check the system for any "bugs" and assure that the facility can operate at its designed performance testing standards. Depending on the type and scale of operation, and assuming no major reworking is required, this may take several days to a month.

Operation: This is the day-to-day use and management of the program or facility. Different programs may operate for several years to more than 20 years.

This above list of major tasks is accurate for implementing most solid waste management options. Because many of the tasks can be performed simultaneously, the time required from design to operation is usually less than the sum of the individual tasks. For a simple yard waste composting facility, the total time required may be three months or less. A curbside collection program may take a year, whereas a materials recovery operation may take two years or longer. For a waste-to-energy or landfill facility, the total time required can be three years or considerably longer.

PROJECT FINANCING

64. What factors are considered when determining whether to finance a solid waste management project?

The most common types of solid waste disposal projects being financed are landfills, transfer stations, composting plants, recycling centers, and waste-to-energy facilities. The financial community will evaluate each of these types of projects on their own merits to see how likely they are to succeed. Areas of concern that will be reviewed include:

- **Waste supply**: Is a sufficient amount of waste available for the project?
- **Technology**: Is the selected technology reliable? Is its performance backed by appropriate guarantees?
- **Environmental compliance**: Will the project be able to meet all foreseeable environmental and regulatory requirements?
- **Markets**: Are secure markets available for any materials or energy that may be produced?
- **Risk allocation**: Have the project risks been allocated and documented in appropriate contracts?
- **Economics**: Are the project costs and revenues projected reasonably? How do they compare with other disposal options? To what extent are they guaranteed or subject to inflationary or market forces?

- **Management**: Does the project management team have the skills and experience to properly manage the development, construction, and operation of the project? Do they have the necessary technical and financial resources to deal with problems should they arise?

65. What type of financing is available for a solid waste disposal project?

Solid waste management projects can be financed in a variety of ways depending on such factors as: amounts to be financed, maturity of the financings, the type of interest rate desired (variable or fixed), time-frame in which funds are needed and the terms and conditions for repayment. Some of the more common forms of financing are:

- Bank loans and lines of credit
- Equity
- Public offerings and private placements

Bank loans and lines of credit: Bank loans are used for small financings (under $3 million) and typically have a variable rate (based on the bank's prime rate) with a maturity of less than 10 years. The up-front costs associated with a bank loan are usually less than a public offering but the interest rate is usually higher.

Lines of credit enable a project to borrow from a particular bank for any purpose up to a preapproved dollar amount. Lines of credit are generally used in the start-up phase of a project when exact financing needs are not yet known and other sources of capital are not available. Lines of credit can be obtained for $1 million to $5 million.

The banks that offer loans and lines of credit are often located within the communities sponsoring the project. As a result, they are often familiar with the projects and the participants. Therefore, these types of financial transactions can often be done on a quicker schedule with less documentation than other forms of financing.

Equity: Equity is usually in the form of a cash investment in the project by one of the participants. Equity contributions have ranged from 5 to 25 percent of the project costs. In privately owned projects, equity contribution is often requested from the private entities involved to show their commitment to the project.

Public offerings and private placements: Public offerings are debt offerings sold to the general investing public. Public offerings for municipalities are typically structured as tax-exempt debt and represent the most common form of financing for municipal solid waste disposal projects costing $5 million or more. Because of the federal and state tax-

exemption, the interest rate on the bonds is typically the lowest available in the market place.

Private placements are bond offerings where bonds are sold to a single or a limited number of investors. The advantage of private placements compared to public offerings is that they allow for more flexibility in the documents and have lower costs of issuance. However, the interest rate on a private placement is generally higher than for a public offering.

66. What are the ownership options of a waste disposal project?

A solid waste disposal project may be owned by a public or private entity. Public entities are typically cities, counties, or special districts (two or more local governments working jointly on a project). Publicly owned facilities retain tax-exempt financing. If the facility is operated by a private entity for more than 20 years, though, the federal government considers the project private and rescinds the tax benefit.

The project can also be owned privately. Often the local government that needs the project requests proposals from firms in the private sector to site, permit, finance, design, construct, and operate the project. The firm offering the most attractive proposal is then granted an exclusive right to develop the project.

Most projects with significant public involvement are being structured today with public ownership because: 1) privately owned projects are facing increasing difficulties obtaining tax-exempt financing; and 2) public entities are placing a higher worth on the residual value of these projects.

V. Appendices

APPENDIX A
GLOSSARY OF SOLID WASTE MANAGEMENT ACRONYMS AND TERMS

ACRONYMS

AC	Authority to Construct
ADI	Acceptable Daily Intake
APCO	Air Pollution Control Officer
ARB	Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CoSWMP	County Solid Waste Management Plan
CPO	Computer Print-Out
CIWMB	California Integrated Waste Management Board
dB	Decibel
DHS	Department of Health Services
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
HDPE	High-Density Polyethylene (plastic)
HRA	Health Risk Assessment
IPC	Intermediate Processing Center
IWM	Integrated Waste Management
LEA	Local Enforcement Agency
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MW	Megawatt
NIMBY	"Not in My Backyard"
NSWMA	National Solid Waste Management Association
OCC	Old Corrugated Containers (cardboard)
ONP	Old Newsprint
PET	Polyethylene Terephthalate (plastic)
PURPA	Public Utility Regulatory Policies Act
RCRA	Resource Conservation and Recovery Act
RDF	Refuse-Derived Fuel
RFD	Reference Doses
RFP	Request for Proposals
RFQ	Request for Qualifications
RWCB	Regional Water Control Board
SIP	State Implementation Plan
SRRE	Source Reduction and Recycling Element
TPD	Tons Per Day
TPY	Tons Per Year
WTE	Waste-to-energy
UBC	Used Beverage Containers
VOC	Volatile Organic Compounds

TERMS

aeration — The process of exposing composting materials to air.

aerobic — Describes the chemical reaction requiring the presence of free oxygen.

air classifier — Machine that separates waste materials using an air stream.

anaerobic — The chemical reactions that can only take place in the complete absence of free oxygen.

anaerobic digestion — The decomposition of organic matter in the absence of free oxygen-producing methane gas.

anti-scavenging ordinance — A regulation prohibiting unauthorized collection of recovered materials set out for collection by a designated collector.

ash — Residue from the combustion of any solid or liquid material. See bottom ash, fly ash.

avoided cost — Waste management cost savings resulting from waste reduction and/or recycling activities. May be measured in terms of avoided disposal fee and/or avoided collection costs. In energy, it is the cost a utility would otherwise incur to obtain/produce power.

backyard composting — The controlled biodegradation of leaves, grass, and other yard wastes at the point of generation.

bag house — See fabric filters.

bale — Densified, bound cube of recyclable material.

baler — Machine used to densify and bind recyclable materials for storage and shipment.

bimetal can — Any metal can composed of at least two different types of metals, such as a steel container with an aluminum top.

biodegradable — Organic material capable of being reduced to its basic elements (carbon, oxygen, nitrogen, hydrogen) by microorganisms.

biomass — Plant materials and animal waste used as a fuel source; may be measured as the amount of living matter per unit area or volume of habitat.

Bottle Bill — A general term for any container deposit legislation.

bottom ash — Solid material that remains on the combustion grates or in the furnace after refuse is burned.

broker — Person or firm purchasing recycled materials from processors for sale to consumers. Normally does not take physical possession of materials.

brown goods — Discarded electronics products, e.g., radios and televisions.

bulky wastes — Items whose large size complicates their handling by normal collections means. See brown goods, white goods.

buy-back center — Usually a commercially operated recycling facility that accepts delivery or transfer of source separated recyclable materials and pays a fee.

capacity — Measure of maximum throughput or output under normal operating conditions.

capacity payment — A type of avoided cost based on the instantaneous amount of capacity made available to a utility for use.

capital costs - Those direct costs incurred in order to acquire real property assets, such as land, buildings, and building additions; site improvements; machinery; and equipment.

cell — Excavated unit area within a landfill in which wastes are placed.

cocomposting — The composting of solid waste with waste water treatment facility sludge.

cogeneration — The simultaneous generation of electrical energy and low-grade heat from the same fuel.

collection — The act of picking up wastes and/or secondary materials from homes, businesses, institutions, and industrial sites.

collection frequency — The schedule for a collection service, e.g., weekly, biweekly, monthly.

commercial recycling program — Recyclables collection service targeted at commercial establishments for the collection of materials including glass and aluminum containers, and cardboard. Often set up by private firms in large cities and metropolitan areas.

commercial solid wastes — Solid waste originating from stores, business offices, commercial warehouses, hospitals, educational, health care, military and correctional facilities, nonprofit research organizations, and government offices.

commingled collection — Pick-up of several recyclable materials mixed together.

compost — Organic material, including leaves, food, wood chips, etc., that has decomposed until it has reached a stable condition.

composting — A method of waste treatment in which organic solid wastes are biologically decomposed under controlled, aerobic, or anaerobic conditions, forming a humus-like product.

consumption — The use of any resource in a given time by a given population.

conveyor — Mechanical device used to move materials between operations

crusher — Mechanical device used to break recycled materials (e.g., glass bottles) into small pieces.

cullet — Crushed glass normally prepared in uniform small pieces.

curbside recycling program — Regularly scheduled pick-up service (weekly, biweekly, monthly) for household recyclables such as newspaper, cans and glass.

dealer — Person or firm who purchases recyclable materials, processes them to meet consumer standards, and transports them to market.

decompose — To undergo chemical breakdown into constituent parts or elements.

densifier — Machine used to compress aluminum cans into a small dense "brick."

designated wastes — Category of wastes falling between conventional municipal solid waste and hazardous waste. It may also encompass types of wastes whose future regulatory status remains uncertain.

detinning — Chemical separation of tin-plated steel into recyclable tin and steel.

diversion rate — The amount of solid waste diverted from disposal through waste reduction and recycling activities.

drop box — A 10- to 40-cubic-yard metal container that can be transported and dropped by truck. Used for the storage of wastes or recycled materials.

drop-off center — A recycling facility that accepts delivery or transfer of source-separated recyclable materials without paying a fee. Often operated by charitable groups for fund raising purposes.

end user — Firms that purchase recyclable materials for use as feedstock to replace the use of raw materials.

energy payment — A type of avoided cost; based on the actual amount of energy transmitted to the utility.

electrostatic precipitator — Air pollution control device in which particulates in the flue gases are electrically charged. Participates are passed between oppositely charged collection plates that attract and remove particulates from the flue gases.

fabric filter — Air pollution control device in which flue gases are passed through a dense fabric that then filters out particles.

feed hopper — A funnel-shaped receptacle for the delivery of solid wastes into the incineration chamber.

ferrous — Any iron or steel scrap that has an iron content sufficient for magnetic separation.

flue gases — Hot gaseous by-product of the waste incineration process to be treated and vented into the atmosphere.

flue gas scrubber — Air pollution control device used to remove acid gases through a reaction with lime.

fluidized bed reactor - Type of waste incinerator in which a sand-like material is heated to high temperatures and circulated in a combustion chamber. Waste is introduced, it ignites, the heat is recovered, and the inert material is recycled.

fly ash — Material which is recovered from flue gases passing through air pollution control equipment.

front loader — A solid waste collection vehicle having a loading mechanism at the front. Also, a vehicle with a scoop at the front, used to load secondary materials into processing equipment of containers.

garbage — Waste likely to decompose, e.g., food wastes.

generator — Individual, business, organization or activity that produces wastes or recyclable materials.

grade — A class of secondary material that is distinguished on the basis of quality, color, content, appearance, density, or other factor.

gross ton — Measure of weight equal to 1,000 kilograms or 2,205 lbs. Also, metric ton, long ton.

hazardous waste — A waste or combination of wastes that because of its quality, concentration, physical, chemical, or infectious characteristics, may either:

> (1) Cause, or significantly contribute to, an increase in mortality, or an increase in serious irreversible or incapacitating reversible illness; or
>
> (2) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported or disposed of, or otherwise managed. (California Health and Safety Code.)

heavy metals — Potentially toxic metals that are persistent in the environment, e.g., cadmium, lead, mercury.

humus — Brown or black material resulting from partial decomposition of plant or animal matter and forming the organic portion of soil.

incineration — Burning of waste to ash that may or may not involve energy recovery. See resource recovery, waste-to-energy.

inert waste — Noncombustible, nonhazardous solid wastes that are unlikely to break down under conditions of disposal in a landfill.

inorganic — Being or composed of matter not containing carbon.

integrated waste management — A waste management strategy that refers to the complimentary use of a variety of solid waste management practices to safely and effectively handle the waste stream with the least adverse impact on human health and the environment.

intermediate processing center — Facility that processes (crushes, bales, etc.) source-separated materials for sale to end users.

landfill — A system of waste disposal in which materials are buried between layers of earth to build up low-lying land.

leachate — Resulting solution of percolating liquid through solid wastes.

leachate collection system — Network of underground pipes used to collect liquid having percolated through a landfill. Liquids are channeled to a reservoir for treatment.

lift — One layer of waste and earth within a landfill.

liner — Earthen or plastic barrier between landfill contents and the ground.

magnetic separator — Machine employing magnetism to remove ferrous metals from a stream of material.

mandatory recycling — Program that requires households and/or businesses to exclude certain recyclable materials from their trash and prepare materials for recycling. Typically implemented by ordinance or statue.

mass burn — Type of waste incineration in which material is burned 'as is' with generally no sizing, shredding or separation prior to burning.

materials recovery facility — A facility that separates commingled recyclable materials (or sometimes recyclable materials commingled with solid waste) and processes them (crush, bale, etc.) for sale to end users.

methane — Gas generated by microbial decomposition of organic wastes.

methane gas collection system — Network of pipes laid within a landfill used to collect and channel gas to a storage and/or incineration point.

monofill — A landfill that disposes of only one type of material, e.g., construction and demolition wastes, ash, or other.

multimaterial — A collection processing system handling more than one recyclable material.

municipal solid waste — Solid waste produced by cities and towns. Usually divided into residential, commercial and institutional, and industrial.

newsprint — Type of paper normally used for printing newspapers. See old newspaper.

noncombustion volume reduction — Describes a set of waste management technologies that reduce the volume of the waste stream through nonincineration means, e.g., composting, pyrolysis.

nonferrous — Not containing, including or relating to iron.

office paper — Waste papers produced by office workers. Includes ledger, computer and bond papers.

office paper program — Recycling activity targeted to office workers. May include source separation of computer, bond, ledger and mixed papers for collection and transportation to a processing center.

old corrugated containers — Cardboard boxes generated in stores, factories, and homes when merchandise is removed from them. Typically excludes wax coated cardboard.

old newspapers — Newspapers that have been distributed to readers and are available for recycling.

operating costs — Reoccurring facility or program costs, such as labor, materials and energy inputs, maintenance, administration, and promotion.

plastics — Manmade materials consisting primarily of polymers containing hydrogen, carbon and oxygen. Typical plastics types found in the waste stream are polyethylene therephthalate (PET, soda bottles) and high-density polyethylene (HDPE, milk containers and polyvinyl chloride [PVC]).

post-consumer waste — Discards that have fulfilled their useful life. Generated by households and businesses. Does not include industrial/manufacturing activities.

primary materials — Nonsynthetic materials used for producing goods. Also raw materials, virgin materials.

procurement — Process of obtaining goods and/or services for the management of wastes.

putrescible — Subject to biological decomposition.

pyrolysis — The chemical decomposition of a material by exposure to high temperature in an oxygen-free atmosphere.

rear loader — Solid waste collection vehicle having a loading mechanism at the rear.

recovered material — A material that has been diverted from the solid waste stream.

recovery rate — Usually expressed as a percentage, it is the amount of solid waste recovered through source reduction, reuse and recycling within a community divided by the total amount of solid waste generated by that community.

recycling — The recovery and reuse of secondary materials in the production of new goods.

recyclable — As an adjective, the technical ability of a material to be reused in manufacturing. As a noun, any material that can be recycled.

redemption — The return of a secondary material to the original supplier or designated center.

refuse — See solid waste.

refuse derived fuel — The combustible portion of solid waste that has been separated form the noncombustible portion through shredding, screening, etc. This process produces a relatively homogenous product that can be burned in a boiler or marketed as a fuel to outside users.

request for proposals — A mechanism for seeking qualified forms or individuals to supply waste management goods and/or services.

request for qualifications — A mechanism for determining the experience, skills, financial resources, and/or expertise of a potential bidder or proposer on a waste management project.

resource recovery — The employment of solid waste to produce energy. Also, generally any form of materials or energy recovery activity.

roll-off truck — Vehicle which picks up and deposits drop boxes at a site.

rubbish — All solid wastes, excluding wood waste and ashes.

scrap — A waste materials that is usually segregated and suitable for recycling or reuse.

secondary market — A firm or operation purchasing secondary materials.

secondary material — Any recyclable material.

septage — A semisolid substance consisting of settled sewage solids, water, and dissolved materials generated by septic tank systems.

set-out — A household or business placing recyclable materials at a designated location for recycling collection.

sewage sludge — Semiliquid material consisting of settled sewage solids, water, and dissolved materials generated by sewage treatment facilities.

shredder — A machine that tears or grinds material to reduce its size.

solid waste — All nonhazardous solid and semisolid materials that are not the primary or intended products of public, private, industrial, commercial, and institutional operations.

source reduction — Activities that reduce the generation of solid waste before it enters the waste stream.

source separation — The segregation and preparation of individual recyclable materials at the point of generation.

special wastes — Wastes that are classified as hazardous only because they contain inorganic substances that pose a chronic toxicity hazard to health or the environment.

subflow — A group of materials within a waste stream that have similar physical and/or chemical characteristics.

thermal host — Any type of processing facility that utilizes a large amount of steam produced from an incineration process.

thermoplastic — A class of plastics that can be melted to a liquid state and rehardened when cool.

tin can — A container made from tin-plated steel.

tipping fee — The charge assessed for unloading solid waste at a processing, transfer, or disposal site. Usually assessed in dollars-per-ton or cubic yard.

tipping floor — Paved area at the waste processing or transfer facility where wastes are dumped prior to processing or repacking.

transfer station — Facility that repacks wastes delivered by solid waste collection vehicles into larger capacity trailers for hauling to more distant disposal sites. Usually employed where the waste disposal site is very far from the generation site.

trash — Wastes that do not include putrescible food or animal wastes, but may include organic materials such as paper and yard waste.

waste composition — The relative amount of various types of materials in a given waste stream.

waste diversion credit — An incentive provided to a recycling activity based on the tonnage diverted from the waste stream.

waste flow agreement — Resolution or ordinance used by a governmental agency to ensure that collected solid wastes are destined to a designated waste processing, transfer or disposal facility.

waste management hierarchy — A preferentially ranked series of the waste management options (i.e., source reduction, recycling, volume reduction, incineration, and landfilling).

waste minimization — Activities leading to the reduction of waste generation.

waste reduction — See source reduction.

waste-to-energy — The set of waste management technologies that incinerate all or part of the waste stream to produce steam and/or electricity.

waste stream — The waste material output of a community, region, facility, or economic sector.

white goods — Discarded major appliances, including refrigerators, stoves, and washing machines.

windrow — A piled row of organic materials for the purposes of composting.

yard waste — Leaves, grass clippings, twigs, and other wastes produced as a part of yard and gardening activities.

APPENDIX B
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